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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 49

TECHNICAL ARTICLES:

The Philadelphia & Reading Terminal R. R. Train-shed; Philadelphia, Pa. (*with inset*)..... 50
Close Instrumental Work on the Pecos Viaduct..... 51
Sewage Purification in America..... 52
Notes on Canadian Railways (*illustrated*)..... 52
The Improvement of Philadelphia Harbor (*illustrated*) 55
Sundry Opinions on Blind Tires for Locomotives..... 56
Corrosion of an Overhead Bridge by Locomotive Gases, Rochester, N. Y..... 57
Bursting Tests of Copper Steam Pipes..... 64
The High Service Water-Works System of New London, Conn. (*illustrated*)..... 64
Patents on Aluminum Producing Processes..... 65
Electric Locomotive for Mines (*illustrated*)..... 66
The Engineering Schools of the United States, XXXVIII..... 66
A Patented Suspension Bridge (*illustrated*)..... 68
Extension of the Outfall Sewer Under the Harbor at New London, Conn. (*illustrated*)..... 68
A New Artificial Stone..... 69
The Iron Ores of Minnesota..... 70

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS.....57, 59

EDITORIAL NOTES.....60, 61

New York Rapid Transit—Blind Tires on Locomotive Driving Wheels—Strength of Copper Steam Pipes—Germs and Filtration of Water—Panama Canal Scandal—Growth of the Electric Railway—Good Roads—Exports of Locomotives.

EDITORIAL:

Letting of Highway Bridge Contracts..... 61

LETTERS TO THE EDITOR..... 62

Fast Trains—The Sulphur Fumes from the Butte Smelters—Some Advantages of a Double-Decked Rapid Transit Tunnel Under Broadway (*illustrated*)—Sewer Records—American Goods in Foreign Markets—Notes and Queries.

CONSTRUCTION NEWS..... .....70, 72

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The gross earnings of railways in the United States for the year 1892 show a substantial increase over those for 1891, according to the "Financial Chronicle." The following table shows the earnings and mileage of 134 railways for the whole year and 40 railways for eleven months:

	1891 Gross earnings.	1891 Mileage.	1892 Gross earnings.	1892 Mileage.
134 Rys. for 12 mos..	$535,288,736	93,319	$563,570,346	94.961
40 Rys. for 11 mos..	346,178,756	37.183	362,807,401	37 373
Total, 174 Rys.....	$881,467,492	130,502	$881,467,492	132.334

This is an increase of 5.01% in gross earnings and 1.4% in mileage during 1892. This is a very satisfactory showing considering that the conditions affecting the crops were not very satisfactory in any section of the country. On the other hand, the conditions affecting the volume of traffic were decidedly favorable. The great crops of 1891 afforded a grain movement in 1892 large beyond precedent; at the same time these crops and also the building operations connected with the World's Fair stimulated general business, giving a large volume of merchandise freight to the railroads. Two important sections of the country did not participate in the improvement, namely, the Pacific Coast and the South, more particularly the latter, where the low price of cotton and the low price of iron, together with some other unfavorable features, caused considerable business depression, while concurrently there was a falling off in the movement of cotton, especially in the closing months of the year, because of the much smaller crop produced in 1892. As a consequence Southern roads did poorly, though there are some important exceptions to the rule.

The state canals of New York, according to the last report of Superintendent Hannan, carried last season 4,281,995 tons, of which 2,404,484 tons were through freight. The Erie Canal alone carried 2,978,832 tons; the Champlain Canal, 1,021,130 tons, and the remainder is credited to the Oswego, Cayuga and Black River canals. The aggregate loss of traffic, as compared with last season, was 281,447 tons.

A plan for a depressed rapid transit railway for New York has been placed before the Rapid Transit Commission by Mr. John Schuyler, a civil engineer in the service of the New York, New Haven & Hartford R. R. Co. He proposes a width of 25 ft., through the blocks, and depressed sufficiently to pass under the streets. He would have only two tracks for express service, with stations 20 blocks apart. He lays out no route and says that the cost, "including damages to property owners," would not exceed $1,000,000 per mile. While the plan suggested is a good compromise between an underground and an elevated railway, and worthy of consideration, it is lacking in local traffic accommodation and the estimate of cost is altogether too low. And how about sewers and pipes in the cross-streets?

The contracts for the construction of the seagoing battleship "Iowa" and the armored cruiser "Brooklyn" for the U. S. Navy, have been awarded to William Cramp & Sons, of Philadelphia, Pa., for $3,010,000 and $2,986,000, respectively. The company proposed to equip them with quadruple expansion engines, but, on advice of the Engineer-in-Chief, this part of the bid has been rejected and in compliance with the recommendations of the bureaus of Construction and Repair and of Steam Engineering, the vessels will be built in accordance with the plans and specifications provided by the Navy Department.

The awarding of the contracts for building the new warships, "Brooklyn" and "Iowa," to Messrs. Wm. Cramp & Sons, for $2,986,000 and $3,010,000, causes Secretary of the Navy Tracy to remark on the late reduction of price for this class of work. The prices here quoted are from 10 to 12% less than for any previous ship of their class. The "Brooklyn" will be larger by 1,086 tons than the "New York," and the cost will practically be the same for both. This reduction is due to the sharp competition of at least four well equipped ship-building firms, the Bath Iron Works, of Bath, Me.; Wm. Cramp & Sons, of Philadelphia; the Newport News Shipbuilding Co., of Newport News, Va., and the Union Iron Works, of San Francisco.

The advantages of the screw over paddle-wheels in forcing a passage through ice were proved last week in New York Harbor. The ice blockade was said to be the worst that has been experienced for 15 years, and the movement of the paddle-wheel ferryboats on both the North and East rivers was greatly impeded. The half dozen ferryboats on the North River which are fitted with screw propellers at each end, however, plowed through the ice with very little trouble, and were able to run nearly on schedule time. The screw propellers, being submerged below the ice level, run as freely as in open water; and if the ice is crowded down, the blades strike it a sharp blow from below which effectually shatters it. The paddle-wheel boats, however, are obliged to run slowly to avoid smashing paddles and paddle-boxes, and in zero weather a short stop is sufficient to freeze the ice around the submerged part of the wheel and prevent its turning. A paddle-wheel boat of the Hoboken line was caught on an ice floe in mid-stream and at the same time her engine stopped on the center, and it was a half hour's work to start it.

The great paddle wheel boats on Long Island Sound have been much impeded by ice; but the new screw propeller boats of the Stonington Line have run closely on their schedule time. It is interesting to note in this connection that the next addition to the Sound [illegible] a new steamer for the Norwich Line, is to be [illegible]ped with twin screws driven by triple-expansion [illegible]nes.

The most serious railway accident of the week was a rear collision Jan. 13 at 55th St., Chicago. An accommodation train on the Chicago & Eastern Illinois R. R., leaving the Dearborn St. station at 7:20 p. m., was run into by a Chicago & Erie express for New York. The accommodation train consisted of three cars. The rear and middle cars were telescoped, and the middle car caught fire from an overturned stove, but all the passengers were got out. About 18 persons were injured, some seriously. The accommodation train had been delayed by a freight train, but the express had no warning of this.

One of the worst car stove accidents on record is reported from Russia. According to the cable dispatches a passenger train of several cars loaded with recruits was running between Siatonsk and Samara when the front car caught fire, it is said, from the accidental overturning of a stove. The blaze swept backward, and the whole train was in flames before the engineer discovered the fire and stopped the train. Many saved their lives by jumping into the snowdrifts beside the track, but 40 men are reported killed and 20 severely injured.

A bridge near Cammal, Pa., on the Fall Brook Ry. is reported to have failed on Jan. 17, while a freight train was passing over it. Several cars went into the river.

According to the first message of Thomas F. Gilroy, Mayor of New York, 171,000,000 gallons of water are now furnished daily to that city, as against 116,000,000 gallons, the daily supply prior to the completion of the new aqueduct. The full capacity of this aqueduct is over 400,000,000 gallons daily, but there is not yet sufficient storage capacity to provide this quantity The mayor points out the importance of preserving the Croton water-shed from contamination, and recommends the acquisition by the city of sufficent land bordering the streams to prevent this contamination.

English government telegraph operators, says Mr. Sherman, U. S. Consul at Liverpool, receive from $2.92 per week for beginners, to $13.62 per week for service in the largest towns. Women start with $2.43, and get as a maximum $8.51 per week. A day's work is 8 hours, and overtime is paid for at 1¼ rate of ordinary pay, and for each hour of overtime 1¼ hours is credited. The London & Northwestern Railway pays its operators from $145.99 to $389.32 per year, for 10 to 12 hours per day, and makes an extra allowance of $12.65 per year in lieu of overtime, no matter how much overtime there is. The Midland Railway pays from $97.33 per annum to $389.32, for 8 hours' work. The Great Western Railway pays for 10 hours per day from $97.33 to $291.19 per year; and to adults from $340.65 to $729.97 per year; no extra pay is allowed for work on Sundays and holidays.

A break in a force main connected with the Brooklyn water-works extension occurred a few days ago, entirely cutting off the supply from that section of the gathering grounds of the works. The recent breakage of one of the main pumping engines, coupled with heavy consumption during the cold weather of this month, resulted in the complete exhaustion of the reserve supply at the Ridgewood distributing reservoir on Jan. 17. This rendered the city wholly dependent upon the Ridgewood pumping station, but the break in the force main on the extension threw the drain entirely on to the old watershed for a time, there being water in storage at the Hempstead reservoir. The main which broke extends around the Baldwin storage reservoir. It was soon sufficiently repaired to allow it to carry a part of its full capacity. A few days ago the water consumption ran up to 82,000,000 gallons, which is 2,000,000 gallons above the capacity of the pumping plant. It has been necessary to diminish the pressure on the distributing mains. The Aldermen have finally taken steps to increase the pumping capacity.

The estimated cost of extending the old two-mile intake tunnels of the Chicago water-works for a distance of 2½ miles is reported as given by Mr. L. H. Clarke, City Engineer, at $778,000. The first of the old two-mile tunnels was constructed in 1864-7, and is 5 ft. wide and 5 ft. 2 ins. high inside of the brick lining. The second tunnel was constructed in 1872-4, is 7 ft. in interior diameter, is parallel to the first, and is 46 ft. from it and is connected with the lake crib of the first tunnel by a cross tunnel running from a shaft at its outer end. The reports at hand do not state definitely whether it is proposed to drive one or two tunnels from the two-mile to the 4½-mile point, but indicate that but one is intended.

Passenger fares on French railways were reduced 10% on second-class and 20% on third-class in April, 1892, by agreement between the government and the railway companies. It is stated that notwithstanding this reduction there has been no falling off in receipts from passenger traffic.

A trans-Pacific cable commission is likely to be appointed by the Canadian government to inquire into the most feasible means of completing telegraphic communication between British Columbia and Australia. A cable line from Brisbane, Queensland, to New Caledonia, Fiji, Samoa and the Sandwich Islands, is already under contract with the Societe des Telegraphes Sousmarine. This company wishes to extend the system to America, and has the option of a terminus at San Francisco or Vancouver. The French company for the line mentioned is to be guaranteed $60,000 per annum for 30 years; $40,000 from France and $10,000 each from New South Wales and Queensland, while the Sandwich Islands guarantees $25,000 annually for 15 years. Canada now wants to extend the system from the Sandiwch Islands to British Columbia. The estimated cost is put at $10,000,000.

A jump of 103 ft. on Norwegian skees, with a perpendicular fall of 36 ft., was recently made at Red Wing, Minn., by Mr. Thorger Hemnestevdt, of that city. The site of the jump was a steep hill, 300 ft. long, with a snow-covered platform so constructed that when the runner passed it he was thrown into the air. A previous record of 102 ft. was made two years ago by Mikkes Hemnestevdt, a brother of the present champion.

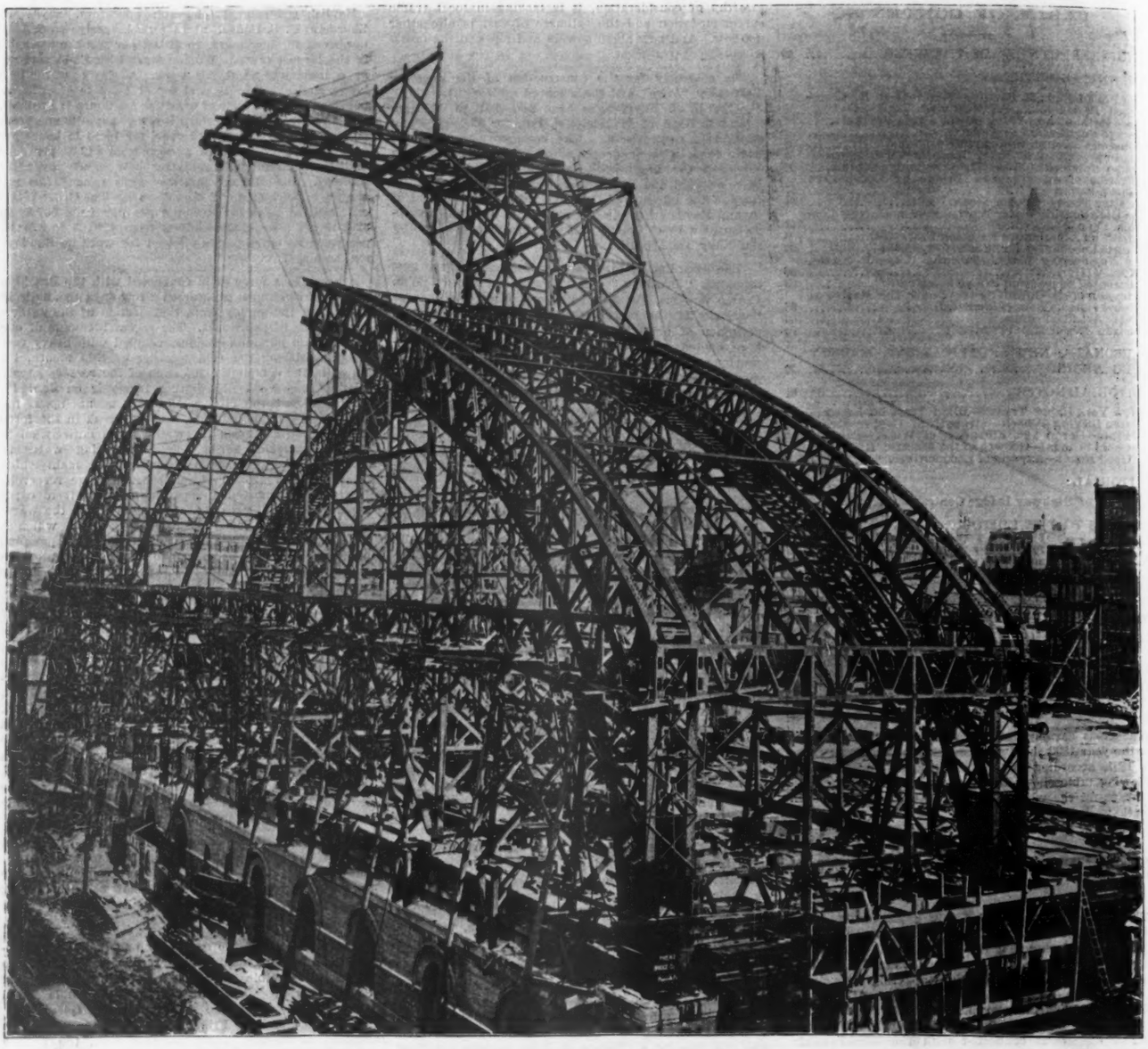
The London, Tilbury & Southend Railway, of England, has followed the example of some eight or ten other railways in Great Britain in abolishing the second class of car and accommodation, and running only first and third class cars.

PHILADELPHIA & READING TERMINAL R. R. STATION; PHILADELPHIA, PA.

I.

(With inset.)

The trainshed of the passenger station of the Philadelphia & Reading Terminal R. R. at Philadelphia, Pa., which we illustrate in detail on our inset sheet and the accompanying cuts, has the greatest single span arched roof of any trainshed in the world; and, indeed, so far as we recall, only two arched roofs of greater span have ever been constructed. These are the roofs of the Machinery Hall at the Paris Exposition of 1889, with a span of 364 ft. 2 ins., c. to c. of end pins, and of the Manufactures Building for the World's Columbian bian Exhibition, at Chicago (Eng. News, Sept. 1, 1892), with a span of 368 ft., c. to c. of end pins. The only other trainshed yet built whose dimensions very closely approach those of the Philadelphia & Reading Terminal trainshed in magnitude is that built at Jersey City, N. J., in 1891 for the Pennsylvania R. R. Co. (Eng. News, Sept. 26 and Oct. 3, 1891). It should be noted, however, that the roof arches for the Broad St. Station trainshed, which the Pennsylvania R. R. Co. will erect at Philadelphia, Pa., (Eng. News, Oct. 6 and 13, 1892,) will have considerably longer spans than those of the Philadelphia & Reading Terminal R. R. trainshed, viz.: spans of 606 ft. 9⅝ ins., c. to c., of end pins. Prior to the construction of the Pennsylvania R. R. trainshed at Jersey City the largest single-span trainshed in the world was that of the St. Pancras terminal station of the Midland Ry., in London, England, which was built 24 years ago.



PHILADELPHIA & READING TERMINAL R. R. TRAINSHED, SHOWING IRONWORK IN PROCESS OF ERECTION

The comparative dimensions of these three structures, as far as we have been able to collect them, are shown in the following tables:

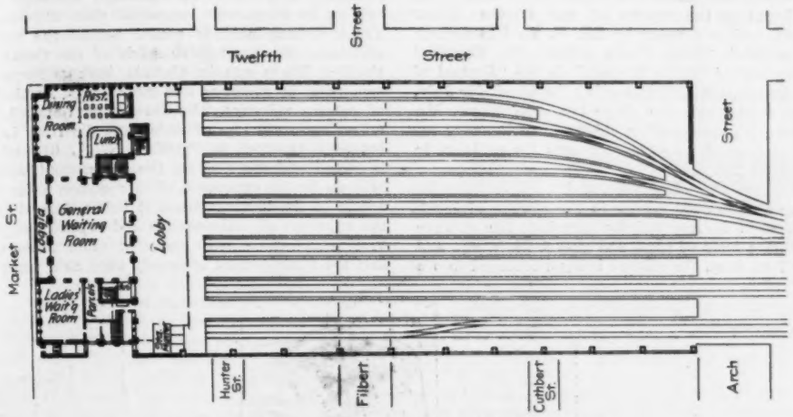
	P. R. R.	P. & R. R. R.	Mid. Ry.
Span of roof trusses, c. to c. end pins	Ft. Ins. 252 8	Ft. Ins. 259 0	Ft. 240
Clear height at center	86 0	88 0	100
Clear width of trainshed, out to out	256 0	266 0	...
Length of trainshed, out to out	652 6	506 8	690
No. pairs of roof trusses	12	11	...
No. of tracks inclosed	12	13	10*

* Including a 25-ft. roadway.

Headhouse.—As will be seen from the plan of the train floor of the Philadelphia & Reading station shown in the accompanying cut, the station is located at the corner of Twelfth and Market Sts., fronting on Market St. and extending to Arch St., crossing Filbert St. The headhouse has a frontage of 266 ft. 6 ins. and a depth of 100 ft. It is eight stories high with a half basement. The basement and first stories are built of pink granite, and the remainder of pink brick, with white terra-cotta trimmings. The architecture is Italian Renaissance. The trains enter the trainshed by an elevated structure, so that the platforms are on a level with the second floor of the head house. Filbert St. runs underneath the tracks, dividing the basement into two parts. The part from Market St. to Filbert St. is used by the railway company for station purposes, and the part from Filbert St. to Arch St. is utilized for a public market. The division of the train floor is shown in the plan. Above this floor the building is fitted up for office purposes. The building is intended to embody, so far as is feasible under the circumstances, the best arrangements and latest improvements applicable to railway passenger stations.

Trainshed.—From an engineering standpoint, however, the greatest interest attaches to the ironwork of the trainshed. The principal dimensions of this structure are: Length, 506 ft. 8 ins.; width, 266 ft.; height, c. to c. of pins, 88 ft., and height from the top of the rails to the top of the skylight, 95 ft. The whole weight of the roof is carried by 11 wrought iron roof arches, with riveted joints, each having a span of 259 ft. between centers of end pins. Each arch is formed by a pair of parallel trusses placed 5 ft. apart, c. to c., and braced vertically and horizontally. These arches are connected by side trusses and purlins, and between each pair

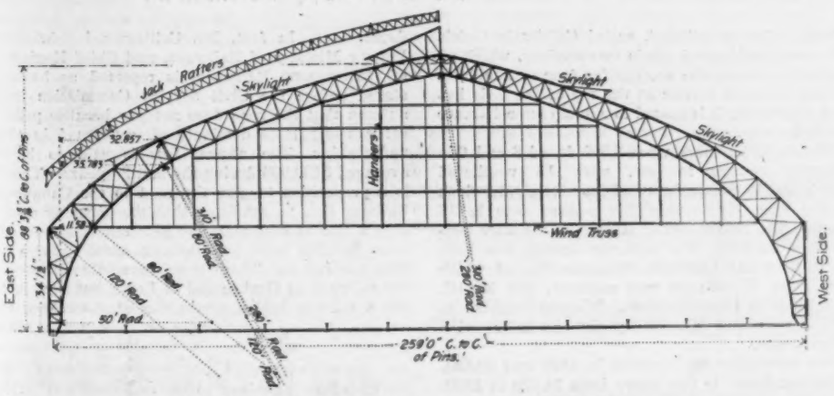
of arches are placed two jack rafters connected rigidly to the purlins by riveted joints. The pair of arches at each end of the structure are also connected by a system of lateral wind bracing, running from the end of each purlin to the opposite end of the one next above. The intermediate arches are braced between the side truss and the first purlin only, the other laterals being omitted. The structure is further strengthened to resist the pressure of the wind by a horizontal wind truss, with curved chords, running longitudinally across the first arch at the Arch St. gable. This truss is riveted to the lower chord of the main arch trusses at the elbow of the arch, and is suspended from



TRAIN FLOOR PLAN OF STATION AND TRAINSHED.

the lower chord of the trusses by hangers. The location of these hangers is shown in the outline elevation of the Arch St. gable, and the detail of their connection with the bottom chord of the arch is shown in the inset. Full details of the horizontal wind truss and the hangers will be given in another issue.

The main arches are, as before mentioned, composed of two parallel trusses, braced together with angle iron. Each truss, comprising one-half of the arch, is built up of wrought iron plates and angles, with riveted joints, and is hinged at the apex and at each foot. One of the feet is also provided with a shoe carrying a nest of expansion rollers to permit free movement with changes of temperature.



ELEVATION OF ARCH ST. GABLE OF TRAINSHED

It is divided into 24 panels from shoe to apex. The main feature of this truss lies in the fact that the individual chords between panel points are curved to conform to a true outline of the arch, requiring exceedingly nice work in shop construction. In this lies the essential difference in design and construction between these arches and those composing the Pennsylvania R. R. trainshed at Jersey City. The plates and angles of the chords are connected by a series of splices. The splices of the top, or tension chord, are made by breaking the chord angles and the covers and web plate at different points, thus forming a connection which would otherwise require heavy and long splice plates. The bottom or compression chord is spliced with ordinary square butt joints, the bottom, cover plate, however, always extending beyond the joint to avoid the use of a short and unsightly splice plate. These splices are so arranged as to divide the truss into sections, in which shape they were transported from the shops to the field, where they were riveted together as erected.

The lower chord of each arch is composed of 4 in. × 1½ in. eye-bars, connecting the pins at the shoes and running underneath the track. The pin at the apex of the arch is 5 ins. in diameter, and 2 ft. 2½ ins. deep, running parallel to the main arches. These rafters have the same curve as the those at the feet are 5 9-16 ins. in diameter each. The sizes of the members composing both chords are fully shown in the illustrations.

The purlins connecting the roof arches, and upon which the wood and tin roofing is laid, are wrought iron lattice girders, 11 in number, 5 on each side and one at the ridge. They are each 44 ft. 9⅛ ins. long and 4 ft. deep, built up of four 5 × 3½ in. 35-lb. angles, with 3 × 2½ in. 17-lb. angle latticing. To those connecting the first and second and tenth and eleventh arches, are riveted plates, with a pin hole, to which the lateral bracing, consisting of square upset rods, is fastened by a clevis.

At right angles to, and riveted to the purlins, are the jack rafters, which are also lattice girders, arches, and extend down and connect with the side trusses. They are placed 15 ft. 2 ins. apart, c. to c., two between each pair of arches, and are connected at the apex by a riveted connection at the ridge purlin, at which point allowance is also provided for expansion and contraction. The lateral bracing is connected to the jack rafters by ⅝-in. plates, riveted to the upper flange of the girder, through which at each end a pin hole is provided for the attachment of the clevises.

Specifications.—The trainshed is built throughout of wrought iron and cast iron. The specifications for the quality and workmanship of the cast iron work, of which there is but little, do not differ from those ordinarily provided for work of this character. All wrought iron used in the tension members of open trusses, and in all laterals, pins, bolts, etc., was required to be rolled directly from the muck bar and to have an ultimate strength of 52,000 lbs. per sq. in. on a full section of test piece; an elastic limit of 26,000 lbs. per sq. in., and a minimum elongation of 20% in eight inches. The specifications for all other wrought iron work were as follows:

All wrought iron not included under above head must be tough, fibrous, uniform in quality throughout, free from flaws, blisters and injurious cracks, and must have a workmanlike finish. It must be capable of sustaining an ultimate strain of 48,000 lbs. per sq. in. (excepting for plates over 24 ins. in width, where it may be 46,000 lbs.), on a full section of test piece, with an elastic limit of 26,000 lbs. per sq. in. All iron to be used in tension, or subjected to transverse strain (except web-plates), must have a minimum elongation of 15% on a length of eight inches, measured after breaking; all iron to be used in compression and for web-plates, of widths not exceeding 24 ins., must have a minimum elongation of 10% in a length of eight inches, measured after breaking, and all iron for web-plates exceeding 24 ins. in width, must have a minimum elongation of 5%, measured in length of eight inches.

When tested to the breaking point, if so required by the engineer, the links and rods must part through the body and not through the head or pin hole. All tension wrought iron, if cut into testing strips 1½ ins. in width, must be capable of resisting, without signs of fracture, bending cold by blows of a hammer, until the end of the strips form a right angle with each other, the inner diameter of the curve of bending being not more than twice the thickness of the piece tested. The hammering must be only on the extremities of the specimens, and never where the flexion is taking place. All plates, angles, etc., which are to be bent in the manufacture, must, in addition to the above requirements, be capable of bending sharply to a right angle at a working heat without showing any signs of fracture. All rivet iron must be tough and soft, and pieces of the full diameter of the rivet must be capable of bending until the sides are in close contact, without showing fracture on the convex side of the curve. Pins 4½ ins. in diameter or less, may be rolled iron, but those of greater diameter must be forged.

The specifications for workmanship did not differ materially from those usually provided for first-class structural work. All the iron work was to be thoroughly scraped and cleaned after erection, and given one coat of red lead in pure raw linseed oil.

The trainshed was designed by Wilson Bros & Co., of Philadelphia, Pa. The Phoenix Bridge Co., of Phoenixville, Pa., were the contractors for the iron work and erection, and all the details of the travelers and methods of erection, which are usually interesting, were designed by their engineers. The details of this portion of the work will be fully illustrated and described in another issue. We are indebted to Mr. Joseph Wood Wagner, of the engineering staff of the Phoenix Bridge Co., for the matter from which our illustrations and this description have been prepared.

CLOSE INSTRUMENTAL WORK ON THE PECOS VIADUCT.

In connection with the illustrated article on the Pecos Viaduct published in our issue of Jan. 5, the following record of instrumental work in locating the piers is of interest: Mr. Kruttschnitt, General Manager of the Southern Pacific Co., writes that Mr. W. F. Kendall, Assistant Resident Engineer, located these piers from a base line 600 ft. long at the bottom of a ravine 300 ft. deep. The spans were 100 ft. in length, made up of a 35-ft. tower-span and a 65-ft. girder, and the highest towers were 321 ft. from the bottom of the ravine to the base of rail. In every instance but one the location was sufficiently accurate to permit the girders to be set bodily on top of the towers, and the connecting bolts to be entered without chipping or reaming. The one exception was a varation of ⅝ in., which required a slight adjustment of the bolt holes. The cantilever span was 185 ft. long, and the difference between the triangulated and actual measurement, by wooden rods after completion, was a little less than ¼ in. The transits used by Mr. Kendall were made by Heller & Brightly, of Philadelphia, says the General Manager.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 28.)

The Mystic Valley Works.

In the summer of 1878 the city of Boston, under the direction of the Water Board, constructed over four miles of main and branch sewers in the valley of the Mystic River to divert the sewage of several tanneries and some house drainage from the Mystic Lake, from which water is drawn to supply a division of the Boston Water Works, to the lower Mystic Lake.

Towns adjoining the lower lake complaining that the sewage discharged into it was a nuisance, legislation was obtained in 1881 which compelled Boston to purify the sewage. After some delay, a system of sedimentation and partial filtration through a trench in gravel was installed. This, even after enlargement, having proved unsatisfactory, as did experiments with a Farquhar mechanical filter, the Boston Water Board, in 1887, instructed Mr. Wilbur F. Learned, C. E., to experiment and report upon chemical treatment of the sewage.

The precipitation works were put in operation in the latter part of 1888, and are described in the report of the Boston Water Board for that year as follows:

The new settling tanks have been completed, and are in successful operation. The works consist of a pump well connected by a brick sewer with the main sewer, a sewage pump, an engine, an engine house, four settling tanks, a sludge well, a sludge pump, and a series of settling basins for receiving the sludge.

In the engine house are three vats, so arranged that the precipitant is fed to the sewage from one vat placed lower and between the other two, in which the precipitant is dissolved; each vat is provided with a steam pipe for heating the water used, and with an appliance for stirring, which is run from the engine.

After the precipitant is fed to the sewage it is raised by pumping to the settling tanks, where, after a tank is filled, it is allowed to settle for about three hours. The clarified liquid is then drawn off by means of narrow stop planks, which are removed one by one. At this season of the year (winter) the tanks can be filled six times before it is necessary to remove the deposited sludge. This is removed through sluices which connect with a sludge well placed in the middle space between the four tanks. From this sludge well the sludge is pumped into a flume, by which it is carried to the settling basins.

The average flow of the sewer is about 400,000 gallons in 24 hours, 75% of which is between 8 a. m. and 8 p. m. After 12 p. m. the flow from the sewer is practically clear water.

The results of several experiments show that 1 volume of sludge is deposited in the tanks to 30 volumes of sewage received. The sludge contains about 4 parts of dry solids to 96 parts of water; the water disappears in the settling-basins, and we have remaining a product sufficiently dry to be easily handled, and containing 4 parts of solids to 12 parts of water. On this basis the amount of "dry product" would be 10 cu. yds. daily. The cost of the works, including the preparation of the settling basins and incidentals, was $10,410.

The operation of the works for the three years 1889, 1890 and 1891 is shown in detail by the following figures:

	Sewage treated, galls.	Pumps run, days.	Av. daily pumpage, galls.	Sulphate of alumina used. Total, lbs.	Sulphate of alumina used. Tons per 1,000,000 galls. sewerage.	Total amt. sludge, cu. yds.	Coal used, tons.
1889.....	99,882,850	308	324,000	403,270	2.02	.....	16
1890.....	19,119,670	335	355,500	323,650	1.36	2,611	19
1891.....	119,404,000	356	335,400	303,780	1.27	2,151*	17

*About.

In 1891 most of the sludge was carted away by a farmer for use as a fertilizer.

Further information regarding these works may be found in the reports of the Boston Water Board, and in a paper by Mr. F. W. Learned, C. E., entitled "Some Facts About the Chemical Treatment of Mystic Sewage," in the "Journal of the Association of Engineering Societies" for July, 1888, from which the above has been taken. Mr. Learned's paper consists chiefly in preliminary experiments made to secure the data for guidance in designing the plant.

Leadville, Col.

The coarse, solid matter in the sewage of Leadville, Col., is removed by passing the sewage through a body of sand and gravel 24 ft. sq., and 6 or 7 ft. deep, the effluent being discharged into a stream, already polluted, called California Gulch. The sand and gravel are in two sections, which alternately receive the sewage for four or five days. When the solid matter at the top of the beds has had time to dry it is moved to a dump some distance from the city.

March, 1891, there were 8,900 ft. of 8 and 6-in separate sewers in use, with 15 ventilated manholes, 40 connections and four Rosewater flush tanks, each discharging 250 gallons once in 12 hours. The yearly cost of caring for the filter beds is given as $450. The sewerage system was built in 1886 by the Leadville Sewerage Co., of which Mr. Thos. W. Jaycox was engineer, and Mr. C. N. Priddy is superintendent. We are indebted to Mr. Jaycox and Mr. Priddy for the information given above.

The population of Leadville in 1890 was 10,834, it having fallen to this figure from 14,820 in 1880.

A contract for furnishing and laying 26½ miles of 38-in. steel water supply conduit, for the city of Rochester, N. Y., has been awarded to Moffett, Hodgkins & Clarke, New York, for $857,553. Bids for both cast iron and steel pipe were asked, as stated in our issue of Dec. 15, 1892.

Electric power on the Erie Canal, says Governor Flower, can be provided at a cost of about 60 cts. per day per boat. As the result of estimates made by an electrical engineer for Gov. Flower, the cost of the entire plant is placed at $1,000,000 for furnishing power between Buffalo and Albany. This estimate includes 14 power stations about 30 miles apart, costing $50,000 each. The expense to the boatmen of fitting up a boat with motor, etc., is placed at about $200. Gov. Flower says that it now costs boatmen $3 per day for mule power, besides the trouble of providing for the animals.

NOTES ON CANADIAN RAILWAYS.

The railways of Canada are distinctly American in the character of their track, structures, locomotives and cars, for Canada has long ago recognized and adopted the advantages and superiority of American practice, while other British colonies are still largely adhering to English practice, in spite of its lack of suitability for the railways of new countries. The following notes as to the railways were made in the course of a recent trip in the provinces of Quebec and Ontario, and some general notes made during the same trip were published in our issue of Nov. 3. It may be said, in opening, that the main lines are in general well built and equipped, and efficiently operated, although the opinion is frequently expressed that the Grand Trunk management is rather behind the times, and lacks the progressive spirit of the Canadian Pacific. There are in Canada both government ownership of railways and government regulation of private railways. The Intercolonial Ry., 1,141 miles, the main line of which extends from Levis (opposite Quebec) to Halifax, N. S., 678 miles, is owned and operated by the government, and is held up by the opponents of this system as an example of its disadvantages, it being claimed that the expenses of maintenance and repairs compare very unfavorably with those of other lines, and that the management is largely used as a political department. In fact, Mr. Collingwood Schrieber, Deputy Minister of Railways, and Chief Engineer of Government Railways, is reported as having stated before the Civil Service Commission last autumn that the road does not pay because political considerations dominate all concerned in the undertaking. The annual loss is said to have averaged $100,000 during the last 20 years. There is a proposition to give the road to the Canadian Railway Co., on condition that the company operates a line of fast steamers between Halifax and some English port, but nothing definite has yet been arrived at. There is no connection between the railways at Quebec and at Levis, but a project for a railway bridge across the St. Lawrence at or near these points has been put forward several times. In June, 1891, the Canadian Government railways aggregated 1,351 miles out of a total of 14,633 miles in the Dominion. All other railways, of which the Canadian Pacific Ry. (6,600 miles), and the Grand Trunk Ry. (3,200 miles), are the

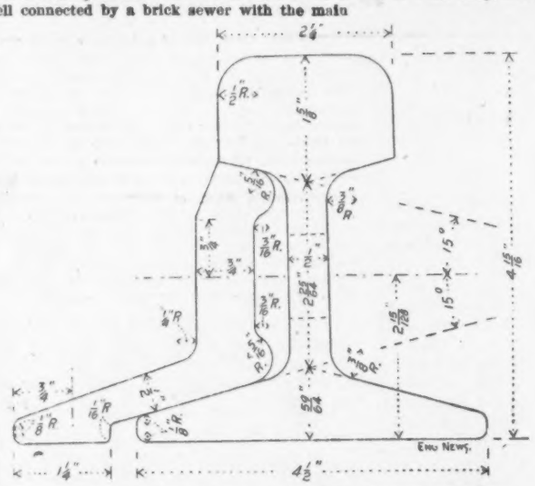


FIG. 1. 72-LB. RAIL; CANADIAN PACIFIC RAILWAY.

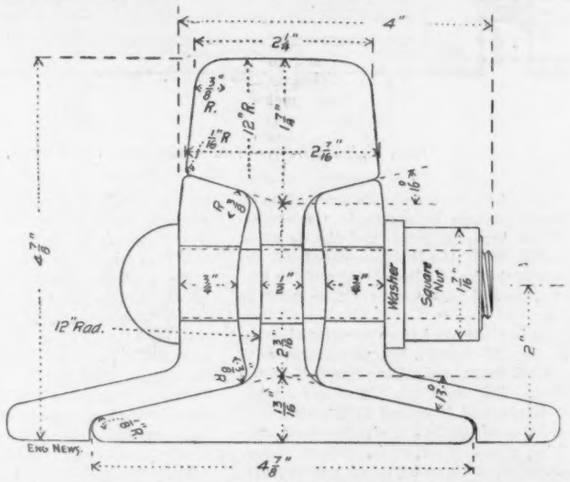


FIG. 4. 79-LB. RAIL; GRAND TRUNK RY.

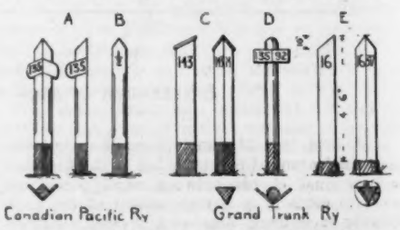


Fig. 3. Distance Posts of Canadian Railways.

largest, are, to a certain extent, under government control. Parliamentary acts must be obtained for new lines and extensions, all construction plans must be submitted to and approved by the Railway Department, and new lines cannot be opened for traffic until they have been inspected and passed by a government inspector. Some statistics of Canadian railways were given in our issue of Sept. 1, and particulars of early railway projects between Canada and New England in our issue of Aug. 4, 1892.

Canadian Pacific Ry.—This great system extends from Quebec and Montreal to the Pacific coast, and has one line from Montreal through New England and the lower provinces to the Atlantic coast, and another line from Montreal to Toronto and Detroit, with through trains to Chicago by the Wabash R. R. Its total length is about 6,600 miles. The handsome Windsor St. terminal station at Montreal was described and illustrated in our issues of March 3 and 17, 1888. The Quebec terminal is being improved, and a new union station is to be built at Toronto by this line and the Grand Trunk Ry., for which Symonds & Strickland, of Toronto, are the architects.

The standard track consists of 72-lb. steel rails of the Sandberg pattern, with three-tie joints, spliced by 40-in. angle bars and six bolts, as shown on Figs. 1 and 2, prepared from drawings for which we are indebted to Mr. P. A. Peterson, Chief Engineer. This track is laid between Montreal and Toronto, and partly between Montreal and Ottawa, and is gradually being extended. The older track consists of 67-lb. rails laid with suspended joints and spliced by 24-in. and 21-in. angle bars with four bolts. With these older joints the corners of the base of the rail were notched for spikes at the joints to prevent creeping. The ballast is mainly of sandy gravel, and in places is extremely dusty. The ties are not barked. Most of the rails are of English make, but some American (Lackawanna Iron & Steel Co.) rails were seen. In the neighborhood of Sudbury, a year ago, the track was in very poor condition, having rotten jack pine ties, the ends of which were broomed and decayed, and in some cases almost gone as far as the edge of the rail. They were badly cut by the rails, and many of the spike heads were ½ in. to 1 in. above the rail, while the spikes were very loose. Some new, unbarked ties were being put in. There are also many deeply cut ties with broomed ends on the line between Quebec and Montreal, where, however, parts of the track are being relaid with the standard 72-lb. rail.

Semaphore signals operated by a winding drum and lever on the station platform are placed at some distance from the stations, in both directions. The switches have oval red targets, with lamps, and the clearance sign at switches is a post carrying a black board with two white disks. On the Montreal and Toronto line trestles are indicated by a post carrying an X of two boards painted white, with a black disk at each end. Some trestles have two outside wooden guard rails, 8×8 ins., both boxed out for the ties. One is 10 ins. clear from the track rail, and faced with angle iron; the other is 20 ins. clear from the first, and is on the ends of the ties. Many of the fences are inclined, having planks or barbed wires nailed to the posts of A frames. Mile and half-mile posts are used, and are of the pattern shown at A and B, respectively, in Fig. 3.

The locomotives, as on all Canadian railways, are built in accordance with American practice, though the Grand Trunk Ry. still follows English practice in a few minor details, as noted later on. The powerful and handsome ten-wheel engines built by the company for its heavy express passenger service were illustrated and described in our issue of Aug. 30, 1890. Several of the older eight-wheel engines have had the side or coupling rods strengthened by a wooden bar at top and bottom, the bars extending the whole length of the rod between bearings, and secured by iron straps. The boilers are lagged with Russia iron, and all other parts painted black, with very little striping. It was noticed on this road and the Grand Trunk that oil is used very wastefully, dripping onto the rails and ballast, and coating the rail joints with a thick deposit of oil and dust. This is particularly noticeable in the Windsor St. Station at Montreal, where the platforms are greasy and dirty and the rails clogged up with the accumulation of dirt adhering to the oil which has dripped off the engines.

The cars have in general an exterior sheathing of vertical strips of wood, varnished but not painted, the color being generally a dark red, though some of the cars are of a yellow color. The lettering is in gold, edged with black. A large first-class car, carried on six-wheel trucks, had 17 rows of seats, accommodating 68 passengers. The interior finish was of light wood, with wooden headlining, and upholstered in red plush. The floor was painted brown and had a carpet in the aisle. At each end was a toilet room. The windows had double sashes and sun blinds, and there

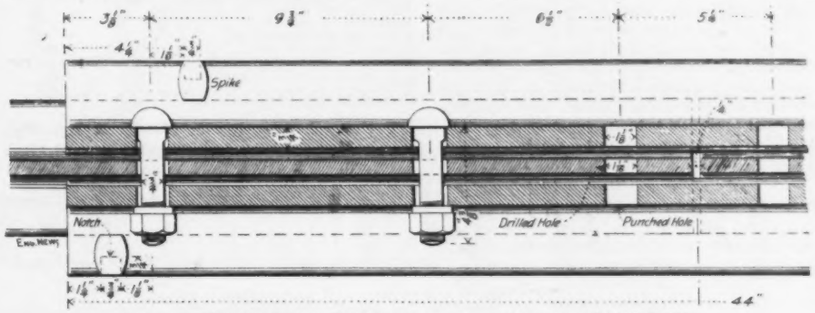


FIG. 2. STANDARD JOINT FOR 72-LB. RAIL; CANADIAN PACIFIC RY.

were five two-light chandeliers in the monitor roof. Another first-class car, with 11 Forney seats in the main part, and a smoking room at each end, had an interior finish of light yellow wood, and was upholstered in peacock blue plush. The lavatories were between the smoking room and the body of the car, with double doors in the aisle. The closets generally have open pans. The ordinary Pullman sleeping and parlor cars were formerly operated, but the company now owns its sleeping, dining and parlor cars, some of which were built by the Cobourg Car Works, Cobourg, Ont., and are very handsome cars. The lamp brackets for tail lights are riveted to the hand rail across the end of the platform.

The transcontinental train in which we traveled as far as Sudbury consisted of two mail and baggage cars, one colonist sleeping car, one first-class day car, and one first-class sleeping car at the rear of the train. At the rear of this car is a large smoking and observation room, with a lounge along each side, which can form a bed at night. The lavatory, bathroom, etc., are between this room and the main body of the car. This is a great improvement upon the ordinary Wagner and Pullman sleeping cars, the majority of which have the ends blocked by lavatories and closets. This car had an interior finish of light yellow wood with brass trimmings and was upholstered in bluish-gray plush. Five sections on each side had the ordinary cross seats, while the middle section of each side had a lounge against the side of the car. The closet was of the ordinary pattern, with open pan and no water, and there was a foul, stale smell, even at starting. In the first-class day car, the smell from the closet was strongly perceptible in the rear seats, and it would appear as though water closets might well be fitted. The sleeping car was built by the Barney & Smith Car Co., of Dayton, O. Vestibuled cars with elaborate interior finish, and upholstered in brownish-gray plush are run on the Montreal and Toronto line. A noticeable feature in the best cars is the use of light yellow wood for the interior finish.

Grand Trunk Ry.—This road has an aggregate length of 3,200 miles, and, like the Canadian Pacific Ry., has a line extending from Montreal through New England to the Atlantic coast, the Grand Trunk Ry. running to Portland, Me. The St. Clair tunnel (Eng. News, 1890) and the Chicago & Grand Trunk Ry. form a part of the system, so that the road has a through line to Chicago, while the Canadian Pacific Ry. gets to Chicago over the Wabash R. R. from Detroit. Preparations are being made for the heavy foreign and local traffic to Chicago next year. Some years ago the company had the chance of a subsidy for a transcontinental railway, but declined the opportunity, which was taken later by the Canadian Pacific Ry., and the latter line now enters into competition also for the traffic between Montreal, Toronto and Chicago. The Grand Trunk has made several attempts to get access to Ottawa, but without success. Within the last year or two it tried to acquire the projected Montreal & Ottawa Ry., which is already built up the west bank of the Ottawa River as far as Rigaud, but the Canadian Pacific has secured control of the line, and its further extension is now improbable.

The standard track is laid with 79-lb. steel rails (English) of the section shown in Fig. 4, and we are indebted to Mr. E. P. Hannaford, Chief Engineer, for drawings of the rail and joint. The joints are square and suspended, spliced by 24-in. angle bars and 4 bolts, with square nuts and round washers on the outer side of the rail, as shown in Fig. 5. The ties are sawed on two sides and are not barked. They are spaced 15 to a rail and about 8 ins. apart in the clear at the joints. The ballast is of gravel, level with the tops of the ties, and extending beyond their ends. Woven wire fencing is being largely used. Bridge floors have 8-in. ties spaced 12 ins. apart, with outside wooden or iron guard rails 11½ ins. clear from the track rail. Double tracking has been nearly completed from Montreal to Toronto, and is being extended toward Hamilton. On the Northern & Northwestern Division (from Toronto to North Bay) the rails are of Cammell toughened steel, rolled in 1885. They are laid with square suspended joints, spliced

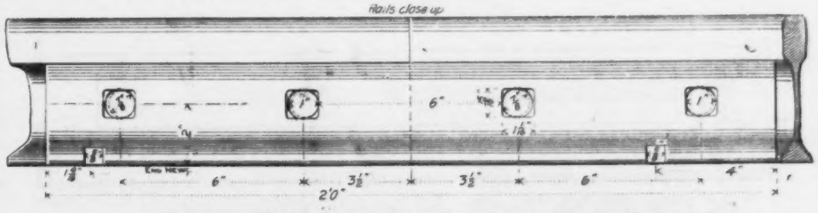


FIG. 5. STANDARD JOINT FOR 79-LB. RAIL; GRAND TRUNK RY.

by 24½-in. angle bars, with four bolts 4½ ins. apart, having button heads, hexagon nuts and Verona washers. Where the rails have been raised considerably by shimming, they are braced by fish plates or wooden blocks, resting on the base of the rail, with one end spiked to the tie. On some parts of the line an old style of joint with wooden bridge plates is still in use, but is gradually being replaced. The joint ties are depressed and carry a wooden "bridge" about 2½ ins. thick and 30 ins. long, to which the rails are spiked, the joint being spliced by 21-in. fish plates and 4 bolts 5 ins. apart.

In the Victoria tubular bridge across the St. Lawrence the rails are spiked to longitudinal timbers, which rest on the transverse I-beams of the bridge floor, and have timber transoms to maintain the gage. A portion of the top plating of the bridge is being removed to afford better ventilation,

and angle-iron stiffeners are riveted along the sides of the opening to prevent any weakening of the structure. Three patterns of mile posts seen on this road are shown in Fig. 3; those marked C and D are on the Northern & Northwestern Division, and those marked E are on the main line between Montreal and Toronto. Semaphore signals are placed at a short distance from the stations, in both directions, and are operated by levers on the station platforms. The blade is pivoted at the middle, and at the back is a small bevel wheel, gearing with a wheel on top of the vertical rod which carries the lamp. There is also a starting signal at the station, generally placed on the edge of the platform roof, and this, like the switch signals, is an oval red target. For three-throw switches one end of the target has an arrow head.

Many of the engines have some decidedly English features, such as the shape of the domes and smokestacks, the Ramsbottom safety valves, etc. An eight-wheel passenger engine seen at Gravenhurst had inclined cylinders, horizontal steam chests and sandbox in the form of a globe. For suburban service compact-looking tank engines are used, having side tanks, four-coupled wheels, a four-wheel leading truck and a trailing pony truck. The boiler, wheels, rods, cab, tank, pilot, etc., are painted a dark reddish brown, with black and white striping. This is in accordance with English practice, while the Canadian Pacific Ry. follows American practice in using Russia iron jacketing for the boiler, and black paint, with very little striping, for all the rest of the engine.

The rolling stock equipment includes some very old and antiquated passenger cars, as well as handsome and comfortable modern cars. Separate cars are used for certain through routes, and are lettered "Through Car, Montreal and Toronto," etc. These have lavatories and closets, and a large smoking room at one end, the seats in which are against the sides of the car, and accommodate eight or ten persons. The main part of the car has seats for 52 to 56 passengers. The plan of one of these cars is shown in Fig. 6, for which we are indebted to Mr. H. Wallis, Mechanical Superintendent. The cars are fitted with oil lamps, which give a wretchedly inefficient light. Some of the first-class cars seat 64 passengers. The truck wheels are large, and spoke wheels are very generally used. The cars are painted a dark Indian or Tuscan red, lettered in gold. Many of the cars running between Montreal and Toronto are fitted with the Allison station indicator, illustrated and described in our issue of Feb. 14, 1891. The following table gives the dimensions of the standard rails of the Canadian Pacific Ry., Fig. 1, and Grand Trunk Ry., Fig. 4:

Canadian Rails.	C. P. Ry. 72 lbs.	G. T. Ry. 79 lbs.
	ins.	ins.
Height	4 1/16	4 5/16
Width of base	4 1/16	4 1/8
Width of head, top	2 1/4	2 3/4
Width of head, bottom	2 1/4	2 1/8
Side of head	Vert	Inc.
Depth of head	1 3/4	1 3/4
Height of web	2 1/16	2 1/8
Depth of base	1/16	1/16
Thickness of web	1/2	1/2
Height to center of bolt hole	2 1/16	2
Radius of top of head	Flat	12
Radius of top corners of head	1/8	3/8
Radius of bottom corners of head	Sharp	1/8
Radius of top fillets	3/8	3/8
Radius of bottom fillets	3/8	3/8
Radius of corners of base	1/8	1/8
Radius of sides of web	Vert.	12
Fishing angles of head and base	15°	16° and 13°
Percentage of metal in head	37.6	35.1
Percentage of metal in web	18.1	16.4
Percentage of metal in base	44.3	48.5

Quebec, Montmorency & Charlevoix Ry.—This line is 21 miles long, and extends eastward along the north bank of the St. Lawrence from the city of Quebec to the village of Ste. Anne de Beaupre. An extension of 10 miles is being built, and a further extension to Murray Bay and the mouth of the Saguenay River is projected. There is little local traffic, but a heavy regular traffic of tourists and pilgrims, as well as of large organized bodies of pilgrims from distant parts, to visit the church of Ste. Anne, noted for miraculous cures effected by a relic of the saint. The track is laid with 56-lb. Barrow (England) steel rails, made in 1887, but at the Quebec end the rails are 67 lbs. per yd., the same as those of the Quebec & Lake St. John Ry. The rails are laid with square supported joints, spliced by 20-in. fish plates and four button-head bolts with square nuts on the outside of the rail. There are 14 ties to a rail. The line joins the Quebec & St. John Ry. on the west side of the St. Charles River. The trains cross the latter company's bridge, and formerly ran to its Quebec terminal station, but the rental charged was considered too high, and now a wooden shanty near the bridge serves for a station, though the company proposes to erect a new station. The road is level and nearly straight.

The equipment consists of first and second class cars, and "pilgrim" cars designed specially for this service, the object being to give large seating capacity in a light car suitable for the low fares charged, and they have helped the company considerably in providing cheap transportation for a people who could afford to pay but little. The ordinary cars are of the American type, the first class upholstered in plush and costing $1,500, and the second class having wooden seats and costing $1,000 each. All the cars are painted a dark green and lettered in gold. The pilgrim cars were designed by Mr. W. H. Russell, General Superintendent, to whom we are indebted for the drawing from which our illustration, Fig. 7, is made. These cars are 45 ft. long and 9 ft. 8 ins. wide over the frames and weigh 38,000 lbs. They were built by the Jackson & Sharp Co., of Wilmington, Del., whose cars were also seen on other small Canadian roads, although passenger, freight and street cars are built in Canada. They have a longitudinal seat along each side, and two longitudinal seats, back to back, down the middle. A water closet, with urinal, is fitted in one corner, and a section of the seat on the opposite corner is made loose to make room for a stove during the winter. The roof is a plain arch, without monitor roof, and is ceiled inside. The interior finish is in poplar and stained cherry and the doors and seats are of ash. The sashes have glass, 22×28 ins., and slide down into the body of the car; no blinds are provided. There are two twin center lamps and four ventilators. The trains are fitted throughout with the Westinghouse automatic brake. On Sundays and fete days these cars are crowded to suffocation. The average train is about 5.57 ordinary cars, and the maximum train load is 21 cars. Mr. Russell states that he has hauled 19 Canadian Pacific Ry. standard passenger cars, fully loaded (971 passengers), with one engine, and thinks he could haul 30 or 32 of the pilgrim cars with the same engine. Three trains one Sunday in September had respectively 7 cars (435 passengers), 9 cars (520 passengers), and 4 cars (158 passengers).

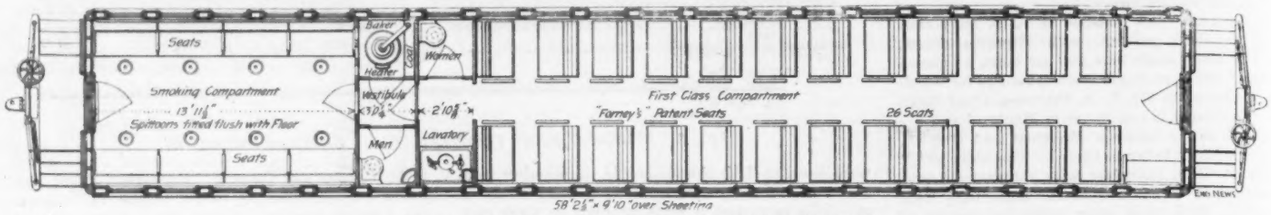


FIG. 6. THROUGH PASSENGER CAR; GRAND TRUNK RY.

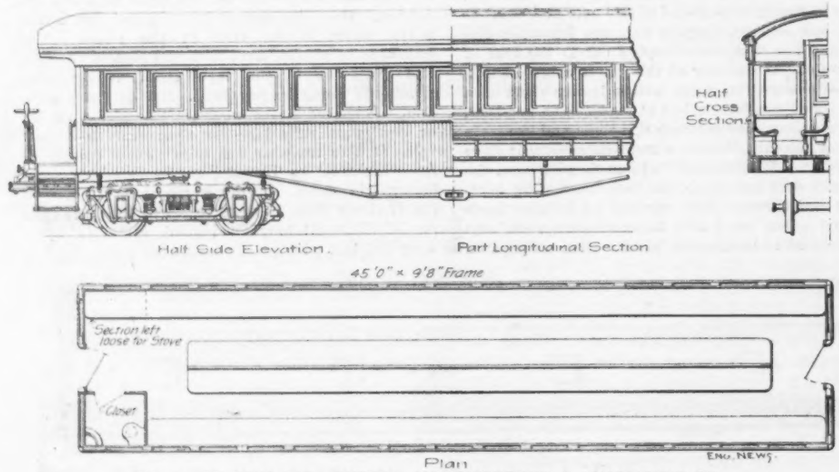


FIG. 7. PILGRIM CAR; QUEBEC, MONTMORENCY & CHARLEVOIX RY.

The engines are of the eight-wheel type, built by the Canadian Locomotive Works, at Kingston, Ont. They have cylinders 17×24 ins., driving wheels 5 ft. 2 ins. diameter, and weigh 86,000 lbs. The working pressure is 140 lbs. Scotch and Sidney (Nova Scotia) coal are used, but the latter clinkers very badly. An analysis of Nova Scotia coal was given in our issue of Oct. 27, 1892. The coal consumption is large, owing to the numerous stops, for as soon as a good even fire is obtained it is broken up in starting from a station. There are 15 stops, including one for water, in the 21 miles, and the trip is made in 1 hr. 5 mins. Mr. Russell furnishes the following particulars of engine performance. Last year the average run was 61.51 miles per ton of coal for one engine, and 56.84 miles for another. They are allowed six miles per hour switching and 3 miles per hour standing with steam up and fire not banked. The total cost of locomotives was about 18.60 cts. per train mile, including fuel, running, supplies and repairs:

	Cents.
Cost of fuel	9.78
Cost of running	6.15
Cost of oil and waste	.49
Cost of repairs	2.10
Cost of total	18.52

The tenders are large, and are supplied by water from the Montmorency River by means of a connection with the flume of the water power electric light plant from Quebec at Montmorency (Eng. News, Nov. 3, 1892.) The boilers are washed out every two weeks, and the scale washes out very easily. At the Ste. Anne end of the line is a water tank supplied from a well, but this is not

used except in case of necessity, as the water from it foams very badly.

Quebec Central Ry.—This line extends from Sherbrooke, to Levis, Que., and is a route for through cars between New York and Quebec. It has a single track laid with 60-lb. rails of the section shown in our issue of March 19, 1892, which are spliced with 30-in. angle bars and four bolts. The rails are laid with square suspended joints, the angle bars extending over both joint ties, and having holes instead of slots for the spikes. There are 15 ties to a rail length. The ballast is of sandy gravel, overgrown with weeds in places, but ditching and clearing were in progress in September. Pit cattleguards, small open culverts and stub switches are used. At one of the water tanks a windmill pump is fitted for supplying the tank. An old engine was seen having a bar frame outside the wheels, extending from the cylinders to the cab, and having stanchions resting on it to support the running board. The cars are first-class and second-class, all painted Pullman color. The lamp brackets for tail lights are not at the corners of the car body, as is usual in American practice, but are on the hand rail across the platform.

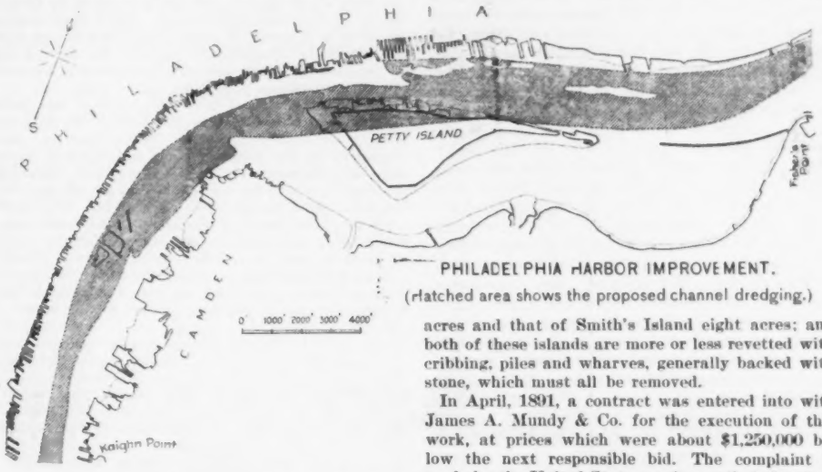
Central Ontario Ry.—This line was built to connect the iron mines at Coe Hill with a lake port on Weller's Bay, near Trenton, Ont.; and as the main object was to get a line through as quickly as possible, no particular care was taken with the location. It was originally intended to run north to Sudbury, the owners being interested in nickel and copper mines in that neighborhood. Since work has been stopped on the Coe Hill mines there has been comparatively little traffic. A good deal of lumber has been cut, but the timber is now pretty well cleared for some miles back, and an extension of 40 miles northward to tap new lumber districts is projected. The line may also be extended at the southern end five miles to the sandbanks, for summer excursion traffic, but there is some doubt as to whether there would be sufficient traffic. The principal town on the line is Trenton, where it has a junction with the Grand Trunk Ry., and from that place it extends northward to Coe Hill, 74 miles, crossing the Canadian Pacific Ry. at 25 miles. South of Trenton the line crosses the Murray Canal by a plate girder drawbridge, and runs to Picton, 30 miles, with a branch from near the canal to Weller's Bay, five miles below Trenton, where a deep-water trestle was built for ore shipment. In view of the expected ore traffic, an eight-stall brick roundhouse was built near here, and a brick machine shop with concrete floor for foundations of lathes, etc., but no tools have been put in. The track is in rather poor condition, as might be expected, and has numerous sags and rough places; north of Trenton it is laid with 56-lb. rails, and south of that point with 42-lb. rails. The ties are of cedar, tamarack, hemlock and ash, and cost 14 to 15 cts. each. The ballast is gravel. The locomotives are all of the eight-wheel type, built by the Rogers Locomotive Works, Paterson, N. J., the Pittsburg Locomotive Works, Pittsburg, Pa., and one by the Canadian Locomotive Works, Kingston, Ont. Lehigh Valley coal is used. A renewal of work on the iron mines is hoped for to improve business. There are also some gold mines along the route, and a branch 9 miles long has been built to the Belmont mines, the property of the Belmont Bessemer Ore Co., of New York, the ore from which is said to be suitable for Bessemer steel manufacture.

Central Ontario Iron Mines.—The mines owned by this company at Coe Hill, Ont., were expected to do a very large business, and at one time a considerable quantity of ore was shipped to Cleveland, O. The United States duty of 75 cts. per ton, however, makes it difficult to find a market in this country, and the establishment of ironworks in Canada does not now seem very probable, as stated in the "Canadian Notes" in our issue of Nov. 3. The suggestion has been made to establish charcoal pig works at the mines. One Pennsylvania ironworks proposed a few months ago to take some ore if it could be delivered at the works for $4.38 per ton. The ore is said to have 68% of metallic iron, with no phosphorus, but a disadvantage is its large proportion of sulphur, although modern improvements in the treatment of sulphury ores will probably eliminate the objection. Mr. T. D. Ledyard, a Canadian mining engineer, in writing of these mines, says that the sulphur entails an additional cost in roasting; but that where other injurious elements are absent, a sulphurous ore, after being properly roasted, can often be used in the manufacture of Bessemer iron. In the report of the Royal Commission on Mines and Their Development, 1890, it is stated that "it seems to be a rich quality of ore, but some of it carries iron pyrites." The shafts were then, as now, full of water.

Altogether about 100,000 tons of ore have been shipped, and there are now about 30,000 tons on the dump. The company will send out a prospecting party with diamond drills, and expects to strike a more favorable grade of ore. The ore body is 40 to 45 ft. wide, and crops out on the surface, where there are three or four open workings. There are three shafts, one 140 ft. and two 150 ft. deep. They are filled with surface water, but the pump pipes are in place, and it is said that no water was encountered in working. The hoisting plant is in good condition, and includes a powerful Gates (Akron, O.) winding engine and two boilers. The mines are now in charge of Mr. Johnson, the company's Foreman of Mines, who is an experienced Welsh miner, and is prospecting for the company. When at work night and day, the output was about 50 to 100 tons per day. Samples of the ore have been selected for exhibition at the World's Columbian Exposition.

THE IMPROVEMENT OF PHILADELPHIA HARBOR.

We have already noted the proposed improvement of the harbor at Philadelphia by the United States Government, which under the River and Harbor Act of Sept. 19, 1890, contemplated the formation of a channel in front of that city about 2,000 ft. wide, with a cross-section of 55,000 sq. ft., and a general depth of 26 ft. at mean tide. To do this requires the removal of Windmill and Smith's islands and the adjacent shoals to a depth of 26 ft., and the widening of the channel at Petty's Island. Part of the material removed is to be used in raising League Island for the new navy yard. The area of Windmill Island is about 17 acres and that of Smith's Island eight acres; and both of these islands are more or less revetted with cribbing, piles and wharves, generally backed with stone, which must all be removed.



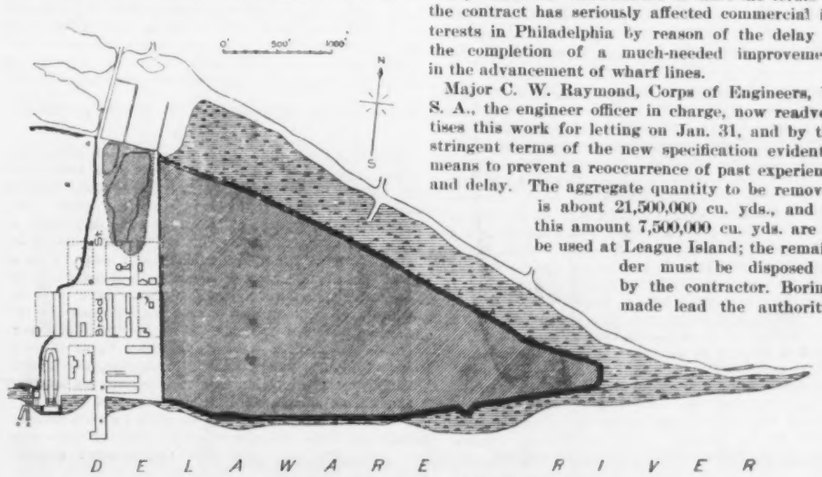
PHILADELPHIA HARBOR IMPROVEMENT.

(Hatched area shows the proposed channel dredging.)

In April, 1891, a contract was entered into with James A. Mundy & Co. for the execution of this work, at prices which were about $1,250,000 below the next responsible bid. The complaint is made by the United States engineers that the plant used by this firm was small and insufficient, and though none of the real difficulties were attacked, the total output for two full seasons' work was only about 800,000 cu. yds. up to December, 1892, when the contract was annulled by the United States, after three extensions of time beyond that fixed in the specifications. The terms of the contract called for the removal of about 5,000,000 cu. yds. in this time instead of 800,000 cu. yds. actually removed. This failure to meet the terms of the contract has seriously affected commercial interests in Philadelphia by reason of the delay in the completion of a much-needed improvement in the advancement of wharf lines.

Major C. W. Raymond, Corps of Engineers, U. S. A., the engineer officer in charge, now readvertises this work for letting on Jan. 31, and by the stringent terms of the new specification evidently means to prevent a reoccurrence of past experience and delay. The aggregate quantity to be removed is about 21,500,000 cu. yds., and of this amount 7,500,000 cu. yds. are to be used at League Island; the remainder must be disposed of by the contractor. Borings made lead the authorities to believe that no rock will be encountered in the contemplated improvement, but the Petty Island channel shows coarse gravel mixed with bowlders, but these are not so large but what they can be removed by dredging. The aggregate length of timber work to be removed is 16,200 ft. Dredging is to be measured in the scows, or in the dippers when deposited on Petty Island, and the deposit and spreading on League Island is to be measured in place, with no allowance for shrinkage or settlement.

Bidders must state the kind, character and number of dredges, scows and other appliances which they propose to use, and their previous experience in work of this character. And in this connection Major Raymond warns bidders that he is acquainted with the character and history of nearly every dredge in this country, and will carefully examine into the statements made and the ability and previous experience of any bidder before recommending an award.



PHILADELPHIA HARBOR IMPROVEMENT.

(Hatched area shows proposed extension of the League Island Navy Yard.)

Work must commence on April 1, 1893, and at least 3,000,000 cu. yds. must be excavated and be deposited before Dec. 31, 1893. The contractor will be required to carry on the work at the following rates: At least 250,000 cu. yds. before April 30; at least 300,000 cu. yds. in the month of May, and at least 350,000 cu. yds. for each month from June to December, inclusive. On League Island at least 700,000 cu. yds. must be deposited and spread before December 31, and the contractor must carry on this work at the rate of 80,000 cu. yds. for each calendar month. Each bid must be accompanied by two guarantees in the sum of $250,000 each, and the successful bidder must give bonds in the amount of $500,000.

These are very stiff requirements; but the terms plainly warn prospective bidders that the Government wishes the contractors to fully realize the difficulties to be encountered, and the responsibility involved. No bids are wanted from irresponsible parties who would go into the work from speculative motives only. Bidders must prove their financial ability and previous experience before their bids will be even entertained; and, in view of the previous experience and delay in the same work as the result of an award "to the lowest responsible bidder" the present precautions and ironclad terms seem wise.

SUNDRY OPINIONS ON BLIND TIRES FOR LOCOMOTIVES.

The question whether "blind," "bald," or flangeless tires should be used on locomotives, and if so, where they should be used, is one on which there seems to be great diversity of opinions and all sorts of practice. In a recent discussion before the New York Railroad Club, the concensus of opinion seemed to be that all tires should be flanged. The Master Mechanics' Association, at its meeting in 1888, discussed the proper location of blind tires, and found important advantages in their use. We reprint below both these discussions, practically in full, and also the matter on this subject contained in Mr. J. G. A. Meyer's book on "Modern Locomotive Construction," and have commented on the subject in our editorial columns.

Discussion at New York Railroad Club, Dec. 15, 1892:

W. H. Lewis (D. L. & W. R. R.).—As far as my experience goes, I never saw any use for the bald tire. We had many places around the yards and shops where the bald tired wheels would invariably drop off the track. I got four Baldwin engines; they had the first pair plain tired, the second flanged, the third plain and the fourth flanged. They wouldn't stay on the track. We changed these, putting flanges on all the tire. We do not follow the practice of turning the tires taper, but turn them straight. We make the flanges on our forward pair up to gage, the next pair with ⅛-in. play and the third pair with 3-16-in. lateral play. This is for ten-wheeled and mogul engines.

Chas. Graham (D. L. & W.), (correspondence):

Regarding the use of all flange tires on the driving-wheels of consolidation engines, we commenced using all flange tires on these engines some six or eight years ago. The result has been satisfactory throughout, the flanges not showing any bad effects on account of putting them on all flanged. Our consolidation engines have a rigid wheel base of 15 ft. with a total wheel base of 22 ft. 2 ins. To the front and back pairs of driving-wheels we give ⅛-in. lateral play, while the two middle pairs have 5/16-in. each. I think that the successful use of all flanged tire depends a great deal upon the proper length of the radius bar, and the lateral play of the swinging center of the engine truck.

We have always put these radius bars shorter on our engines than is done in general practice, viz., about 4 ft.; by doing this and keeping the center line of the truck axle at right angles to a tangent at the point of contact at the flange, or on the radial line of the curve, we allow the flange to come square against the rail on the sharpest curves. We give the links of the swinging center of the engine truck lateral play enough to allow the flanges of the front and second pairs of drivers to come up against the rail, so that the engine truck wheel flange and the first two pairs of driver flanges will each do an equal share of guiding the engine around the curve, while the back pair has more play than the middle pair, thus relieving the strain on the flange on the inside rail of the curve. Engines made in this way run around curves of 11° (521 ft. radius) without any trouble, nor do their flanges show any unusual wear.

Some time ago the Dickson Manufacturing Co. built some consolidation engines for the N. Y., Ont. & W'n. Ry. with both middle pairs of driving wheels without flanges; in delivering these engines they had to pass over a portion of our track; in doing so one of them was off the track two or three times, to my knowledge. One of these curves was a 11° curve, where our consolidation engines ran every day; the track was all right, but the middle pairs of wheels, which were flangeless and had side play, dropped off the rail. I have understood since that they are using all-flanged tire on this class of engines, and on these engines I speak of they did not turn off the inside flange left by the wearing of the tire, but left it on so as to form a flange, in time, as I am informed. This I think may be accepted as favorable to having all flanged tire on driving wheels for consolidation engines. We have found no objection in using them and feel perfectly satisfied with our experience with them.

R. C. Blackall (D. & H.).—Our practice has been very similar to that cited by Mr. Lewis. We have for some years built our heaviest freight engines with flanges on all the wheels. We do not, however, make any such allowance for lateral play as Mr. Graham mentions, and I do not see how he can get along allowing his forward wheels ⅞-in. lateral play. This is at least twice as much as we allow. We have some pretty sharp curves on our road; one near Albany being 22°; and we have no trouble with this class of engine.

A. E. Mitchell (Erie).—I would like to ask Mr. Lewis if when these engines have run some time, you do not find considerable lateral wear in your driving boxes?

Mr. Lewis.—No.

John A. Hill.—On the Denver & Rio Grande they used a small wheel, heavy 10-wheel engine for passenger service, with the main pair of wheels without flanges. They develop very little lateral play, except on this main pair of wheels. I have seen these engines wear to a lateral play between the hub and driving boxes of ⅜-in. in a few months.

W. C. Ennis (N. Y., S. & W.).—I agree with Mr. Hill in every particular, having noticed the same phenomena. I have noticed Mr. Lewis' engines very often with all flanges and often wondered that I never saw any flange wear or evidence of unusual wear between the hub and the driving boxes.

Angus Sinclair.—I made a long trip lately on the Western roads and noticed that the practice is becoming almost general to abandon the bald tire. On the Atchison, Topeka & Santa Fe, they are using flanges on all tires of consolidation engines and get better results than with the bald tire. On the Colorado Midland, they began by using two pairs of the wheels with bald tires, and had so much trouble that they changed to flanged tires, and found it much more satisfactory than the other plan. I am persuaded that when our motive power men become convinced, the practice of using the flanged tire will soon become general.

Discussion at 1888 Meeting of Master Mechanics' Association.

Mr. Briggs (K. Cy., M. & B.).—We have some ten-wheel engines which have a flanged tire in front, and are cutting very badly. We also have some with a bald tire in front that are not cutting much. The flanged tire engines have worn so that they have a great deal of lateral motion in their truck boxes. The bald tires have not shown much lateral wear. I have heard it contended that it should be a flanged tire in front, and also that there should be a bald tire in front. This question has caused considerable correspondence between the officials of our road and the Baldwin Locomotive Works, and other works in this country, besides among master mechanics, and I find great diversity of opinion with reference to the matter.

Mr. Jacob Johann.—I have had engines with forward drivers flanged and engines with forward drivers blind, and from the difference in their operations I am personally convinced that the forward drivers should not be flanged. Practically, you want to make your engine an eight-wheel engine, and allow your forward drivers to go as they please, and in that way you get much better results. That has been my practice for several years. In all engines I had with forward drivers flanged, whenever we turned them we slipped the tire off the front ones and put it on the middle wheels, and vice versa, and connected them in that way.

With reference to the lateral motion and the engine's freedom for passing on a crooked road, it is absolutely necessary to have a certain amount of lateral play in the driving wheels and truck wheels also. If you do not give it, the engine will take it, as Mr. Briggs remarks, and to their own disadvantage. They will cut and grind, and you will get a bad surfaced wheel. If you give it at the start you will have no trouble. I remember some years ago, on a road that I was on, we had to put in a very sharp curve; probably 14°or 15°. I was requested to get an engine ready to do that work, and when we had her ready it struck me that I had better experiment a little first, to see if I could get around that curve with that engine. I did not go down by daylight, when everybody would laugh at me, but I went at 12 o'clock at night, and took another engine behind. We did not get 100 ft. on that curve before the engine went off. We took the engine back to the shop, and the next day I jacked her up and gave her more lateral play between the driving hubs, and cut out the truck center to move 1½ ins. After that the engine went around that curve all right, and worked there for a year and never got off at all.

Mr. Briggs.—We have three Pittsburg ten-wheel engines on the road that have been there for two years. We have eight ten-wheel Rogers engines, that have been there only about eight months. All have bald drivers in front. The Rogers engines have worn until they have got ¾ in. lateral play in their truck. The Pittsburg engines have scarcely ⅜ in., and the Pittsburg has a swing-motion truck, and the Rogers a rigid truck. The wear on the flanges of the Rogers is very perceptible; the wear on the flanges of the Pittsburg engine is not perceptible at all. Is this advantage due to the swing-motion truck under the Pittsburg engines or not? My opinion is that the swing-motion truck is a great factor in retarding lateral wear.

Mr. Mackenzie.—We have quite a number of ten-wheel freight engines which have the blind tire forward. They will go anywhere that an eight-wheel engine will go, and we use them in yard service, and fail to see any wear whatever on the flanges of these engines. They have rigid trucks, and the tires wear just as well as they do on the eight-wheel engine. If the flange is on the forward wheels you must have a lateral motion truck. You could not run a consolidation with a rigid truck, and you could not run a mogul with a rigid truck, in my opinion, for the wheel base is so great in a mogul or consolidation, that there must be some lateral play forward, as Mr. Johann said. He is a great advocate of rigid truck for engines, but he is a great advocate of a swing truck on cars. Now, if the play of the center of his truck, 1½ ins. each way, does not make a swinging truck, I fail to see where the point is. Thus, for a ten-wheel engine my preference would be for a blind tire forward, with a rigid truck; with a mogul or consolidation, a swing truck and the forward driver flanged.

Distribution of Flanged Tires in the Various Classes of Locomotives (from "Modern Locomotive Construction," by J. G. A. Meyer).—In a large majority of eight-wheeled passenger engines, in which four of the whole number of wheels are driving wheels, all the driving wheels have flanged tires. We have noticed only a few of this class of engines in which one pair of drivers—the front ones—had plain tires, leaving only one pair of driving wheels—the rear ones—to guide the engine over a curve. This, we believe, to be dangerous practice. All wheels in this class of engines should have flanges.

In a great number of mogul engines, in which six wheels of the whole number are driving wheels, the front and rear driving wheels have flanged tires; the middle pair have plain tires. We believe this to be the best practice, for the following reasons: All locomotives have a tendency to sway in front from side to side; this is objectionable. Now, a mogul engine has only a two-wheeled truck (generally called a pony truck) in front, and such a truck without the aid of the flanges on the first pair of drivers is not suitable to guide the engine steadily on a straight track; neither is it suitable to guide it safely over a curve. In short, more than two wheels with flanges (particularly when these wheels are truck wheels) are needed to guide the engine steadily in front.

In ten-wheeled engines, in which six wheels of the whole number are driving wheels, as shown in Fig. 3, the rear pair of drivers and the pair next to it have flanged tires. In these engines, the four-wheeled truck in front is generally considered to be sufficient to guide the engine steadily on a straight track and safely over a curve without the aid of flanges on the front driving wheels.

In consolidation engines, in which eight wheels of the whole number are driving wheels, the distribution of flanged tires differs somewhat on the various railways. All these engines have in front a two-wheeled—that is, a pony—truck, and since, as we have stated before, a two-wheeled truck is generally considered insufficient to guide an engine steadily on a straight track or safely over a curve, we find that nearly every engine of this class has flanged tires on the front drivers. As to the other driving wheels under the same engines, we often find the rear pair and the pair next to it with flanged tires, leaving only one pair of driving wheels (the pair next to the front ones) with plain tires. This arrangement seems to indicate that some designers consider two pairs of the whole number of wheels, including truck wheels, to be necessary for the purpose of guiding the rear end of the locomotive, and two pairs of wheels to guide the front end.

But this arrangement is by no means a universal one, as we frequently meet with consolidation engines in which only the rear and front pairs of driving wheels have flanged tires, leaving the two intermediate pairs of driving wheels with plain tires. This arrangement seems to indicate that if one pair of wheels with flanges is sufficient to guide, as is generally the case, the rear end of a mogul engine, one pair of wheels with flanges will also be sufficient to guide the rear end of a consolidation engine, and that plain tires on the two intermediate driving wheels will allow the engine to curve easier. In a few instances we find the flanged

tires distributed so as to bring the flanges on alternate driving wheels. In such cases the rear and third pair of driving wheels, counting from the rear end, will have flanged tires, the second pair from the rear and the front pair will have plain tires. Our favorite arrangement is to have flanges on the front and rear driving wheels; these, we believe, will guide the engine steadily, and allow it to curve easily.

Lastly, we occasionally meet with consolidation, mogul, and ten-wheeled engines under which all the driving wheels have flanged tires.

CORROSION OF AN OVERHEAD BRIDGE BY LOCOMOTIVE GASES, ROCHESTER, N. Y.

One of the most annoying and dangerous inconveniences connected with the use of structural ironwork in localities where it is subjected to contact with the gases of combustion given off by locomotives is its rapid deterioration by corrosion. The accompanying drawings bear striking witness to this fact. Every engineer connected with the maintenance department of a large railway is painfully familiar with it. The iron lining and rails in tunnels; the chords and floor beams of overhead bridges; the roof trusses of trainsheds, and even the ornamental ironwork of the stations themselves are subject to this corrosion. No method yet tried has been successful in entirely obviating this, except the expensive one of inclosing the metal in some material impervious to these gases. Various kinds of asphaltic and other specially prepared paints have been tried, but with so little success that many of the larger railways have abandoned their, use and rely (when they rely on anything but "habit" or the "grace of God" to keep the bridge up) entirely upon frequent coatings of

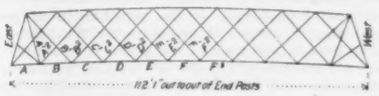


Fig. 1, Diagram of Bridge Truss.

red oxide of iron, mixed with pure, raw linseed oil to delay the corrosion as much as possible. The protection of the iron roof of the Baltimore & Ohio R. R. tunnel at Philadelphia, by hollow firebrick casing, was described in our issue of Nov. 17, 1892.

Although numerous cases are instanced where this corrosion has taken place to the extent of not only weakening iron bridges and other iron structures, but of actually making them unsafe, there is almost nothing in engineering literature treating scientifically of the chemical action which takes place, and the concomitant conditions and elements necessary to its most rapid work of corrosion. In a general way it is well known, of course, that a combination of the sulphurous gases of combustion with the moisture of the atmosphere to form sulphuric acid is in a very great degree responsible for it. The corrosion is probably aided to some extent by the chemical and mechanical action of the heat, and the force of the blast with which the gases impinge against the metal. This is witnessed by the more rapid corrosion of those members of overhead bridges which are located directly over the tracks. On these members the life of paint is often a matter of but a few weeks.

An interesting instance of such corrosion on an overhead bridge has been communicated to us by Mr. J. Y. McClintock, City Surveyor of Rochester, N. Y., and is shown in the accompanying cuts. The bridge in question carries East Main St. over the main tracks of the New York Central & Hudson River R. R. at the west end of the company's freight yards, at East Rochester, N .Y. It is a triple triangular truss with riveted connections, and is 112 ft. 1 in. long, out to out, of end posts. The top and bottom chords are made up of angles and webs, and the diagonals are pairs of angles, which are latticed for compression members. The floor beams are of iron, and are from 17 ft. to 19 ft. above the track, and the stringers to which a plank flooring is spiked, are of oak. The bridge carries a wagon road, two sidewalks and an electric railway, and was built in 1879.

All of the measurements were taken in August, 1892, and the figures, therefore, show the amount of corrosion in 13 years. The locations of the members upon which they were taken are shown in the accompanying diagram (Fig. 1) of the north truss of the bridge. The measurements for the original section were taken upon a portion of the members where the paint was sound, and where no corrosion had taken place. The areas given in Table 1 have been calculated from the corresponding dimensions and for square angles; it being assumed that the loss of area in this calculation due to omitting the fillet of the angle was compensated for by the gains due to the curved ends of the legs. This involves only a slight error of no practical consequence in comparing the areas before and after corrosion.

TABLE 1.—Showing Decrease in Section of Angles in 13 Years by Corrosion from Locomotive Gases.

Member.	Original Section.	Area, sq. ins.	Reduced Section.	Area, sq. ins.	Dec. % in area.
A2	Angle, $3\frac{7}{16} \times 3 \times \frac{5}{16}$ ins.	2.43	Angle, $3\frac{3}{4} \times 2\frac{13}{16} \times \frac{3}{16}$ ins.	1.80	25.9
B1	" $4\frac{1}{16} \times 3 \times \frac{5}{16}$ ins.	3.78	" $4\frac{5}{16} \times 3 \times \frac{3}{16}$ to $\frac{1}{4}$ ins.	1.90	49.7
B2	" $3 \times 3 \times \frac{11}{32}$ ins.	2.03	" $2\frac{7}{8} \times 2\frac{13}{16} \times \frac{7}{16}$ to $\frac{1}{4}$ ins.	1.32	34.9
C2	" $3 \times 3 \times \frac{5}{16}$ ins.	1.77	" $2\frac{7}{8} \times 2\frac{7}{8} \times \frac{5}{16}$ ins.	0.979	44.7
D1	" $3 \times 3 \times \frac{5}{16}$ ins.	2.10	" $2\frac{7}{8} \times 2\frac{7}{8} \times \frac{5}{16}$ ins.	1.37	34.7
D1	" $3 \times 2\frac{15}{16} \times \frac{5}{16}$ ins.	1.92	" $2\frac{13}{16} \times 2\frac{9}{16} \times \frac{1}{4}$ to $\frac{5}{16}$ ins.	1.23	35.9
D2	" $3 \times 3 \times \frac{7}{16}$ ins.	1.77	" $2\frac{13}{16} \times 2\frac{9}{16} \times \frac{1}{4}$ to $\frac{5}{16}$ ins	0.68	61.5
E1	" $2\frac{15}{16} \times 3 \times \frac{5}{16}$ ins.	1.92	" $2\frac{7}{16} \times 1\frac{7}{8} \times \frac{1}{16}$ ins.	0.937	51.2
E2	" $2\frac{3}{4} \times 3 \times \frac{5}{16}$ ins.	2.01	" $2\frac{7}{16} \times 2\frac{1}{16} \times \frac{7}{16}$ ins.	0.902	55.1
F1	" $2\frac{5}{8} \times 3 \times \frac{5}{16}$ ins.	1.96	" $2\frac{5}{8} \times 2\frac{5}{8} \times \frac{5}{16}$ ins.	0.902	53.9
F2	" $2\frac{5}{8} \times 2\frac{5}{16} \times \frac{5}{16}$ ins.	1.92	" $2\frac{1}{16} \times 2\frac{1}{16} \times \frac{7}{16}$ to $\frac{5}{16}$ ins.	0.851	55.6

The sections of the angles shown in Fig. 2 were drawn from the figures given in the table. They are merely diagramatical drawings to show the relative proportion of the metal eaten away only, without any attempt to indicate the location of the corrosion, and should be studied with this understanding.

The figures given in Table 1 are self-explanatory. They show decreases in the sections of these angles running from 25.9% to 61.5%, it being in most of them over 40%, or at the rate of over 3% per year. An examination of them gives rise to some rather interesting reflections as to the probable factor of safety allowed in the construction of the bridge, and as to the entire wisdom of the present tendency to work iron structures carrying a heavy, rapidly-moving live load so closely to their limit. Similar measurements taken on the web plates exhibit similar results, as is shown by the accompanying table, and as might be expected:

Member.	Original thickness.	Reduced thickness.
Web, C.	$\frac{5}{16}$ in.	$\frac{1}{4}$ in.
" C, D.	$\frac{5}{16}$ in.	$\frac{1}{4}$ in.
" F.	$\frac{5}{16}$ in.	$\frac{7}{32}$ in.
" F2	$\frac{5}{16}$ in.	$\frac{7}{32}$ in.

In connection with these figures we append the following excerpt from a letter from Mr. McClintock, to whom we are indebted for the matter from which the tables and the accompanying cuts have been prepared:

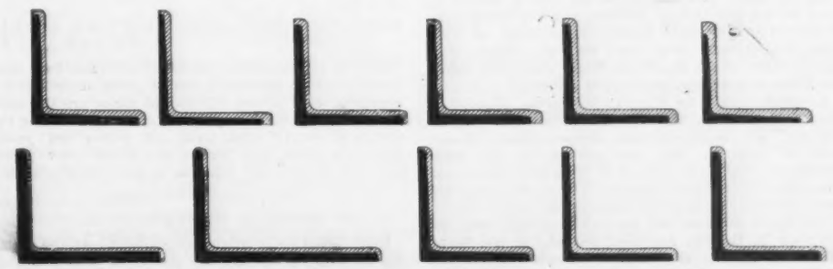


FIG. 2. DIAGRAMS OF ANGLES IN MAIN ST. BRIDGE, ROCHESTER, N. Y., SHOWING CORROSION BY LOCOMOTIVE GASES IN 13 YEARS.

The Cross hatching shows proportion of section destroyed by corrosion.

The stringers of the bridge were of oak, and, as far as I can ascertain, have not been removed since the bridge was built. They show no signs of decay except to a small extent upon their tops around the spikes which held the flooring. In general the stringers seem to have been preserved by the gases from the locomotives. The floor planks were made to fit closely around the diagonals, and all of the corrosion was confined to the ironwork below the flooring. While the iron floor beams and bottom chords are badly eaten into over their whole surfaces, the most active corrosion has taken place at the intersections of the diagonals with the lower chords. It is evident that this was due to water following down the diagonals and absorbing the sulphurous gases from the locomotives, thus being converted into sulphuric acid of greater or less strength. While there are no definite signs of failure apparent, yet upon the passage of an electric car there is a tremulous vibration almost amounting to swaying which seems to indicate that the bridge is working hard. The corroded portion remained attached to the metal until knocked off with a hammer, and was usually very hard. In most cases the section looked full until repeated hammering started the scale. The greatest amount of corrosion has occurred immediately over the track upon which the traffic is heaviest. It is apparently about the same on all sides of the member. I judge from personal experience of the force of the blast from passing locomotives that it would be impossible to make any known paint or asphalt adhere to the ironwork immediately over the tracks. At the time of erection the bridge was painted with two coats of red lead in boiled linseed oil, and the portion of the ironwork below the flooring has been painted but once since. This was in 1886, and two coats of red lead in boiled linseed oil were used. At that time the iron was found to be very badly corroded. It was painted from ladders and cleaned with a putty knife only.

PERSONAL.

Mr. Wm. E. Sutton, Superintendent of the Brunswick Water & Light Co., Brunswick, Ga., died Jan. 10. He was 45 years of age.

Mr. T. A. Allen has been appointed Chief Engineer of the Louisville, Evansville & St. Louis R. R., with headquarters at Evansville, Ind.

Mr. C. Millard, Chief Engineer of the Charleston, Sumter & Northern R. R., has also assumed the duties of Superintendent of the road.

Mr. E. S. Johnson has been appointed Chief Engineer of the Sioux City & Northern R. R. and Sioux City, O'Neill & Western Ry., with headquarters at Sioux City, Ia.

Mr. H. M. Steele, Assistant Engineer on the New York, Lake Erie & Western R. R., has accepted the position of Southern agent of the Hall Signal Co., with office at Baltimore, Md.

Mr. Rudolph Hering, of New York, the well known sanitary engineer, has been appointed Consulting Engineer for the sewerage system of Washington, D. C., and the District of Columbia.

Mr. George C. Smith, Assistant General Manager of the Missouri Pacific Ry., has been appointed General Manager of the Kansas City, Wyandotte & Northwestern R. R., with offices at St. Louis, Mo.

Mr. W. C. Downing, Engineer of Maintenance of Way on the Richmond Division of the Pennsylvania R. R., was married recently at Tacoma, Wash., to Miss Walker, formerly of Richmond, Va.

Mr. Thomas S. Sedgwick, M. Am. Soc. C. E., San Diego, Cal., has been appointed by the Mayor to fill the vacancy in the Board of Water Commissioners of that city occasioned by the resignation of Mr. T. Shaw.

Mr. W. H. Calhoun, Chief Engineer of the Gurley's & Paint Rock Valley Ry., has been appointed Chief Engineer and Superintendent of the Decatur, Chesapeake & New Orleans Ry., with headquarters at Fayetteville, Tenn.

Mr. H. C. Ives, Superintendent of the Chicago Division of the Atchison, Topeka & Santa Fe. R. R., has been appointed General Purchasing Agent, vice Mr. W. G. Tuller, resigned, and Mr. C. F. Resseguie

formerly Superintendent of the Southern Division, has been appointed Superintendent of the Chicago Division.

Mr. Epes Randolph has been appointed General Superintendent of the Newport News & Mississippi Valley R. R. and Ohio Valley Ry., vice Mr. M. B. Cutter, resigned. Mr. Randolph will have his headquarters at Louisville, Ky., and will have charge of the transportation and motive power departments.

Mr. A. B. Ellsworth, Jun. Am. Soc. C. E., died Jan. 10. He was a member of the firm of Ellsworth Bros., civil engineers and surveyors, Buffalo, N. Y.; was a graduate of the Massachusetts Institute of Technology, and for three years prior to April last was Resident Engineer for a Pittsburg testing laboratory, at Athens, Pa.

Mr. Edgar Mills, a brother of Mr. D. O. Mills, of New York, and president of the national bank of D. O. Mills & Co., Sacramento, Cal., died on Jan. 11, at San Francisco. Mr. Mills was born on Oct. 18, 1827, in North Salem, Westchester Co., N. Y., was educated as a civil engineer, and in that capacity was engaged on the early surveys for the Hudson River Railroad. He went to California in 1848, and was first engaged as a merchant and then as a banker. He was president of the Eureka & Palisades R. R. Co., and was connected with many other corporations on the Pacific Coast.

Mr. John Fritz has resigned his position as Superintendent of the Bethlehem Iron Works, Bethlehem, Pa., and has been succeeded by Mr. Owen Leipert. Mr. Fritz retains the position of Consulting Engineer; Mr. R. W. Davenport, formerly Assistant Superintendent, has been made Second Vice-President of the company, and Mr. Robert H. Sayre, Jr., will succeed him as Assistant Superintendent of the works. He has for some time been Acting Assistant. Albert L. Colby, the head chemist, has been promoted to Metallurgical Engineer, and will have the superintendency of the blast furnace.

NEW PUBLICATIONS.

STATE BOARD OF HEALTH OF MASSACHUSETTS: Report for 1891. S. W. Abbott, M. D., Secretary; F. P. Stearns, C. E., Engineer. 8vo. pp. xxxviii., 927; many tables, charts, maps and diagrams.

This report is fully up to the usual standard of the reports of the Massachusetts State Board of Health, which is saying much, as frequent commendation in these columns testifies.

Among other things the report presents the advice given during the year to cities and towns regarding water supply and sewerage; it also gives the results of examinations of water supplies and rivers, and detailed accounts of the work done at the Lawrence Experimental Station. The work of this station relating to sewage purification, as set forth in the report, was noticed at length in our issue of Dec. 15, 1892 as was the work relating to water purification, in our issue of Jan. 5, 1893. The section of the report which relates to the pollution of streams contains the results of special studies made during the dry season of 1891, when the streams were low; also the results of a special study of the Blackstone River above and below the Worcester sewage purification station.

A valuable paper by Prof. T. M. Drown, Chemist of the Board, on "The Effect of the Aeration of Natural Waters," was reprinted from advance sheets, in our issue of Aug. 25, 1892, and another by the same author, on "Dissolved Oxygen in Waters of Ponds and Reservoirs at Different Depths," was also reprinted from advance sheets in our issue of Sept. 29, 1892.

The report contains two papers of especial value by Mr. Gary N. Calkins, Assistant Biologist of the Board The first of these is on "The Microscopical Examination of Water," in which the Sedgwick-Rafter method is described in detail, improvements suggested, and possible sources of error pointed out. Mr. Calkins' second paper is on "Uroglena, a Genus of Colony-Building Infusoria Observed in Certain Water Supplies of Massachusetts," and is accompanied by four fine colored lithographed plates, on an enlarged scale, from drawings by Mr. Calkins, showing colonies, monads and characteristics of uroglena. Mr. Calkins states that uroglena is of great interest, both from its rarity and its colony building habit, while when it does develop in a water supply it imparts a most disagreeable taste and odor to the water. This odor appears to result from the disintegration of the colonies into individuals instead of from decomposition, the process of disintegration apparently giving off an oil contained in the monad which causes the taste and odor.

In the winter of 1892 uroglena developed in large numbers in the ponds from which the water supplies of Norwood and Plymouth, Mass., are taken, which accounts for Mr. Calkins' studies, as set forth in the report.

The Secretary of the Board, S. W. Abbott, M. D., contributes an interesting paper on the "Geographical Distribution of Certain Causes of Death in Massachusetts," in which he studies geographically the mortality statistics of the 20 years 1871 to 1890, from measles, scarlet fever, diphtheria and croup, smallpox, typhoid fever, cholera infantum, phthisis and pneumonia. Colored maps showing the average mortality for the period by towns are presented.

POOR'S HANDBOOK OF INVESTMENT SECURITIES. A Supplement to "Poor's Manual of Railroads." 1892-93. New York, 1892; H. V. & H. W. Poor; 8vo, cloth; pp. 986; maps; price, $4.

The third number of this publication, which, as stated in the title, is a supplement to the well known "Poor's Manual of Railroads," has been much enlarged by the inclusion of new matter and the greater completeness with which matter contained in former numbers is presented. The aim of the book is to furnish to general investors a compendium of facts concerning a very large proportion, if not all, investment securities. The amount of matter contained on this subject is very large and well arranged, and the work seems in all respects a worthy companion to the same firm's older "Manual of Railroads."

INTERSTATE COMMERCE COMMISSION; Sixth Annual Report. Pub. doc., 8vo, paper; pp. 75.

In our issue of Dec. 22 we gave a brief abstract of the contents of this report from an advance summary. Perusal of the complete report shows more clearly the urgent need of action by Congress to enable the Commission to enforce the law. That the efforts of the Commission to prevent unjust discriminations, and further a better and honester management of railways should be thwarted at every turn by the refusal of witnesses to testify in investigations, is too absurd a situation to be a permanent one.

TRADE PUBLICATIONS.

ELECTRIC AUTOMATIC SIGNALS.—Block Signaling, Electric Interlocking, Special Electric Signal Protection, Automatic Audible Signals. Hall Signal Co., New York and Chicago. 8vo.; pp. 62, 21, 11 and 19, respectively; illustrated.

These four pamphlets, descriptive of the various details and applications of the Hall system of electric automatic signals are profusely illustrated and very elaborately printed in a high degree of typographical excellence. The half-tone reproductions of photographs of signals on different roads are excellent examples of this class of illustration, and there are numerous illustrations of the different parts of the apparatus, as well as diagrams of track, showing the location of signals and switches, etc. The Hall system has already been described in our columns, and is now in use to a greater or less extent on several railways, either for regular block signaling or for special protection, as at bridges, etc. It is applicable to single and double track working, and is interlocked with the switches on the block sections. The operation of the system and the details of the plant and apparatus are very fully described. The special protection includes the Stewart-Hall train order signal, to prevent an operator from giving a clear signal before he has delivered the order intended for a train. The audible signals are for highway crossings, signal cabins, drawbridges, etc., to announce the approach of a train.

HYDRAULIC JACKS.—Watson & Stillman Hydraulic Machinery Works, New York. 12mo., pp. 37; illustrated.

This is an illustrated catalogue and price list, with descriptions of different forms of jacks, directions for repairing, etc. Among the special forms are the claw jack, Vreeland traverse pit jack, a jack for moving the motors of electric cars, track and piston rod jacks, traversing jacks, jack screws and screw claw jacks, etc. The Tonkin tube expander is also manufactured.

SOCIETY PROCEEDINGS.

NEW ENGLAND RAILROAD CLUB.—At the meeting on Jan. 11, the relative merits of steel and iron in rolling stock construction were discussed. Mr. Geo. Richards said that breakages of cast iron driving wheel centers were becoming common, and many railways were adopting cast-steel centers in their place. Mr. Lauder said that steel staybolts had been tried and abandoned, and the same would prove true of steel piston rods, connecting rods and parallel rods. He was having breakages of steel piston and parallel rods every few days. Whether steel or iron is the better material for crank pins is an open question. Breakages of cast-iron driving wheel centers were due, he thought, to improper design rather than poor material. It it because other countries have not such good and reliable cast iron that cast iron wheels and wheel centers are not in use there. Mr. Marden said that the Fitchburg R. R. had tried steel axles some years ago with unfavorable results; but he believed that steel was now produced of better and more uniform quality. Mr. Adams would not use steel axles, as he had had bad luck with some that he tried a number of years ago. Mr. Lauder also distrusted steel axles, and thought they wore faster, and that hot boxes were more common with them. Mr. Sinclair denied that a steel axle was more liable to heat than an iron axle. He had investigated the question and found no evidence to support that theory. Of course, the quality of steel must be specified in ordering axles, otherwise a poor quality of steel may be used. The Manhattan Elevated R. R., in New York city, uses steel axles exclusively. They know very closely the length of time which a steel axle will run with safety, and by removing them before they reach the danger limit they prevent accidents due to their breakage. There is no difficulty with lubrication. The quality of iron on the market is all the time deteriorating, while steel is rapidly being perfected and made more reliable. Mr. Graham said that the cars of the West End Street R. R., of Boston, were all equipped with steel axles, and the use of steel axles on the Pennsylvania R. R. was also instanced. Concerning steel and iron connecting-rod strops, it was claimed that the iron strop would show a crack in the corner before it would break. On the other hand, it was claimed that steel tired wheels generally show fracture for some time before the final break occurs.

At the next meeting the question whether the club shall return to its former custom of holding monthly meetings will be voted on.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.—The annual meeting will be held at the court house, Springfield, Ill., Jan. 25. The president, S. S. Greeley, Chicago, will deliver an address, and the following papers are to be presented: Notes on Hydro-Geology of Illinois in Relation to Water Supply, D. W. Mead, Rockford; Best Practical Methods of Constructing Hard Roads, J. E. Miller, Monmouth; Brick Pavements, T. S. McClanahan, Monmouth; Surveying a Parallel of Latitude, Prof. I. O. Baker, Champaign; Rules for House Drainage, R. E. Orr, Chicago; Mathematical Exactness as Found in Our Tables of Sines and Cosines, D. L. Braucher, Lincoln; Prevention of Cholera in Municipalties, S. A. Bullard, Springfield; Special Assessment Law of Illinois; Its Just and Its Unjust Features.

The following topics will be presented for general discussion: 1, The proper construction of public highways; 2, Is the continuance of the office of county surveyor desirable; 3, Is the perpetuation of section and quarter corners so necessary for the public good that it should be done at the public expense; 4, What are the features of a perfectly equitable special assessment law, and what is the matter with the law of Illinois; 5, The smallest fall allowable in tile drains for the various sizes of tiles; 6, In the light of the present time is the brick pavement the best pavement; 7, What is necessary to supply the inland cities of Illinois artificially with potable water; 8, Auxiliary lines in the location of railways; 9, Good country roads; how made and how paid for; 10, From whom comes the present demand for permanent hard roads, from the user for pleasure or from the user for traffic.. The standing committees of the society will report. S. A. Bullard, Secy.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Jan. 7, President James Christie in the chair, and 52 members and visitors present, Mr. E. V. d'Invilliers presented a memorial on the death of Mr. Joseph N. du Barry, active member (Eng. News, Dec., 29, 1892).

Prof. Angelo Heilprin gave an interesting address on "The Scientific Results of the Peary Expedition," illustrated by photographs projected by the lantern. The expedition under Lieutenant Peary did not have for its object, as many erroneously supposed, a nearer approach to the North Pole than had yet been reached, but was planned with a definite object, the determination of the northern boundaries of Greenland, which was carried out with unusual fidelity. The basis of operation was not, as usual, the steamship, but the mainland, and the trip extended from McCormick Bay northeastwardly across the ice cap. The entire round trip, 1,300 miles, was accomplished on foot, sledges being used only to carry supplies, etc. The country was found to be bounded by a chain of mountains on both the eastern and western shores, and the trip started at the western shore at an elevation of from 2,500 to 3,000 ft., and continued rising to the apex of the Humboldt glacier. The ice cap terminated at about 82° north latitude, and open country followed it northward. The northeastern coast was reached in latitude 81° 37', about 4½° farther north than had yet been discovered. From this point the directions and general character of the coast in both directions was established for a considerable distance, although it could not be closely explored, on account of the rugged basaltic bowlders with which it was everywhere covered. The physical features were found to be quite uniform throughout the country. The mountain ranges averaged about 5,000 ft. in height, occasionally reaching 10,000 ft. or higher. The basaltic bluffs and bowlders on the coast, and the numerous fiords made it very similar to that of Norway. Inland, between the mountain ranges, there is an apparently endless sea of ice, entirely covering and hiding the true topography. The expedition solved the problem of the northern termination of Greenland, by showing that it does not extend to near the Pole, or northeastwardly, as has been generally supposed. It was also found that glaciers were projected northward toward the Pole, and therefore Greenland could

hardly have had any connection with the American ice of the great Ice Age, as has often been supposed by geologists. A narrow border country, having a good vegetable growth and an animal life, identical on the east and west sides, extends all around Greenland. The summer temperature there is about the same as that of a mild winter here; the winters are much colder than in this locality, but not more so than in some of our Western states. There is a perfect, but very diminutive, forest growth of birch and willow. Poppies, anemones, buttercups and other bright colored flowers bloom in favored localities, and butterflies and mosquitoes are abundant. The country up to the 73d degree belongs to Denmark; north of that is No Man's Land, probably because its resources have not made it worth an official claim and protection. The true Esquimaux are found north of Melville Bay, and now number approximately 250. They seemingly observe no religious forms whatever; they live largely upon uncooked food, are quick of perception and in adapting means to ends, and are absolutely honest. The expedition to be undertaken next season will attempt to completely locate the northern boundary of the country and to study the open sea beyond.

L. F. Rondinella, Secy.

ENGINEERS' CLUB OF MINNEAPOLIS.—At the meeting on Dec. 8 the secretary, Mr. Cappelen, read a report upon the trip made in October to West Superior, Duluth, and the Vermillion iron range by members of the Engineers' Club of Minneapolis, and the Society of Civil Engineers of St. Paul, by invitation of the civil engineers of West Superior.

The party proceeded, by special train, to the works of the West Superior Steel & Iron Co., inspecting the rolling mills, the shops for structural work, and the pipe foundry. The mills were busy turning out plates and angles for the whaleback steamers now being constructed under the supervision of the inventor, Mr. Alexander MacDougall. The shops were partly finished, being enlarged to receive new machinery, including some machines for the manufacture of the Heath rail joint (Eng. News, Sept. 19, 1891). In the pipe foundry some 5 ft. and 6 ft. pipes were being turned out for culverts for some of the Northwestern railways. The bids for water mains in Minneapolis for 1893, show that the West Superior people were underbid by only 1 cent per ton by the firm that got the contract.

The new dry dock is said to be the largest sweet water dock in the world. At the ship building yards two whalebacks were under construction, one being the largest ever built, the "Columbus," 362 ft. long, 12 to 18 ft. draft, with capacity for 5,000 passengers, and 4,000 tons of freight. This vessel is for the World's Columbian Exposition traffic. The heaviest plates are ½-in., and most of the material was ⅝-in. thick. The total amount of metal required was said to be 2,500 tons, all manufactured in West Superior.

The party then proceeded to Two Harbors, about 27 miles from Duluth. This is the shipping point for all the Vermillion ore output, and has splendid facilities for handling the material. It is at the foot of a very heavy grade running for some eleven miles to Highland. The maximum grade is 137 ft. per mile (2.6%) going north, rising to 1,760 ft. above the sea, to the divide, or 1,158 ft. above Lake Superior. Going south the maximum grade is 66 ft. per mile (1.25%). The maximum curve is 7°. The Mesaba range is 1,610 ft. and Vermillion Lake 1,373 ft. above the sea.

Mr. Owens, Superintendent of the Duluth & Iron Range R. R., entertained the party with matters pertaining to the construction and maintenance of the road, which is 115 miles long to Ely, the terminal point, Tower being 21 miles south of Ely. The rails are being gradually changed from 56 to 80 lbs. and the road double tracked. Although on the heavy grade from Highland to Two Harbors the handling of a loaded ore train is difficult, only one accident has occurred.

During the trip toward Tower it was deemed advisable not to go on the Mesaba range, where the work at present is only surface strippings, but to go right through to Ely, where the party was met by Superintendent Pengilly of the Chandler mine, who took them to the power house. The machinery is all Allis engines. Four 6-ft. drums are operated and the 1⅛-in. steel cables used for hoisting last from 14 to 16 months. The Chandler Iron Co. is mining on 80 acres of land, having four shafts; 300 ft., 402 ft., 359 ft., and 450 ft. deep, all vertical. Borings have been made 100 ft. below the lowest level and ore found. The machinery was started in 1888, and the progress is shown by the following statement of the output:

	tons.		tons.
1888.....	57,000	1891.....	373,000
1889.....	303,000	1892.....	650,000
1890.....	336,000	Total.....	1,719,000

The mines are worked in two shifts of ten hours each, and the wages range from $1.65 to $2.32 per day. Heavy timber is used throughout. The headings are about 11 by 12 ft., with bents 4 ft. apart. The roofs are supported on 4 ft. slabs. After all ore has been removed, the "sand" is let down and used as back filling, causing large depressions and fissures to show on the surface. The mine was lighted by candles only.

Next day the special train took the party to Tower, where the mines were visited. The deepest shaft is 558 ft., on a slight incline. The formation is quite different from that of the Chandler mine; very much less timbering is required and much larger headings are worked. The method of payment of wages is also different; the men take a contract for so much a foot and can work as much as they please. The Tower mines have arc electric lights, besides the candles. The danger at the mines is in the "hangings," or the nearly vertical soapstone walls following up the ore. These "hangings" are, therefore, occasionally supported by ore pillars and arches left to support the walls. The company has large machine and blacksmith shops. The country is very rough and broken. The air compressing plant is located at the shore of Vermillion Lake, north of the mines. This lake is some 40 miles in length, and full of islands. The drainage is toward Canada. Allis engines are in the lead as at Ely.

The party then proceeded to Duluth, where a banquet was given by the engineers of that city and a visit paid to the inclined railway. This is a double track elevated road running two cars, one going up and one coming down, with a seating capacity of 300 each when hard crowded. It runs from West Superior St. to the top of the hill, where it connects with an electric street railway. The party then departed for St. Paul and Minneapolis via the Omaha and Duluth railways, which furnished free transportation both ways.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The annual meeting was held in New York Jan. 18. Mr. Cohen, President, in the chair; Mr. Collingwood, Secretary; Past Presidents Greene and Worthen on the platform. The Secretary read the reports of the Board of Directors, Treasurer, etc., abstracts of which we shall publish in a later issue.

The committee on award of the Norman Medal for the year 1892 announced that it had been awarded to Mr. William Starling, for his paper on "Some Notes on the Holland Dikes."

The committee on award of the Rowland Prize for the year 1892 announced that it had been awarded to the paper on the "Red Rock Cantilever Bridge," by Samuel M. Rowe, Stillman W. Robinson and Henry H. Quimby. Honorable mention was also made of the following papers: "Inland Sewage Disposal, with Special Reference to the East Orange, N. J., Works," by C. Ph. Bassett; "American Irrigation Engineering," by Herbert M. Wilson; and "The Brazos River Harbor Improvement," by George Y. Wisner.

The secretary read a letter from Mr. Sandford Fleming, Chairman of the Committee on Uniform Standard Time, stating that there was not much to add to the information presented in previous reports. He gave his experience in Europe during the summer of 1892, and stated that great progress was being made in Australia, largely due to the work and reports of the American Society of Civil Engineers. On motion of Mr. North this report of progress was accepted with thanks and the committee continued.

The Committee on Uniform Tests of Material presented no report. The Committee on Units of Measurement presented no report.

Mr. Fteley, Chairman of the Committee on Impurities of Domestic Water Supply, presented a brief report. The committee has ascertained the discouraging prospects of obtaining the necessary information, as shown by the experience of the American Water-Works Association, and has come to the conclusion that it is not now advisable to go further, and, therefore, asked to be discharged. The report was accepted and the committee discharged.

Mr. Hunt, of the Committee on Standard Rail Sections, made a progress report, stating that the matter of the final report is now in the hands of the Secretary of the Society. The report was received, and the committee continued.

A communication was read from the Board of Directors in regard to the badge of the Society, and it is proposed to send out a circular and ask for suggestions for a new design. The report of the Board of Directors on a plan for effecting the selection of the nominating committee was read and accepted.

Mr. Read moved that a special committee be appointed to consider the question of the adoption of a code of ethics, and, if it thinks it desirable, to report upon such a code. Mr. Herschel said that this was a very important matter in the history of the Society and the profession. There is some dispute as to whether a civil engineer is a member of a profession or merely a calling. The other professions, generally accepted as such, have codes and courts of ethics, and it is largely by the absence of these that engineers have not been considered as professional men, or given the respect accorded by the public to members of the other professions. Mr. Cooper said that engineering is not a profession, and that there should be no code further than that one engineer should treat another as one gentleman would treat another. Most of them are salaried men, devoting their time to one object, which is not the case with lawyers, doctors or the clergy. Principles of conduct may be laid down, but they cannot be formulated. Mr. Harris agreed with Mr. Cooper, and stated that many engineers are not members of associations, and are widely scattered. The only practical code is to do unto others as you would that they should do to you. Mr. Brush thought the first part of Mr. Read's resolution should be kept quite distinct from the second, but Mr. Herschel, Mr. Fitzgerald, and others thought that a sample or draft code should be presented for argument and discussion. General Greene thought there could be no fully established code. Mr. Cohen said that the meeting could not pass a resolution for the appointment of a committee, but, under the constitution, could only refer it to the Board of Direction. Eventually, by a vote of 52 to 8, the following resolution was adopted:

Resolved, That a special committee be appointed, whose duties shall be: 1. To consider the propriety of the adoption by the Society of a code of ethics for the profession; 2. If the committee shall decide that it is desirable and advisable that a code of ethics should be adopted by the Society they shall proceed to prepare and report to the Society at some future meeting such a code of professional ethics.

In regard to the Engineering Congress at the World's Fair it was stated that 91 papers have been promised, many of which will be in foreign languages, and as ordinary translations of technical matters are very unsatisfactory volunteer offers for translation by members are requested.

It was voted to hold the annual convention at Chicago, at the time of the Engineering Congress, which will be at the end of July and beginning of August.

Officers for the ensuing year have been elected as follows: President, William Metcalf, Pittsburg, Pa.; Vice-Presidents, E. L. Corthell, Chicago, Ill.; Charles Macdonald, New York, N. Y. Directors (to serve three years): W. S. Pope, Detroit, Mich.; F. P. Stearns, Boston, Mass.; J. T. Fanning, Minneapolis, Minn.; O. H. Landreth, Nashville, Tenn.; J. Foster Crowell, New York, N. Y.; H. G. Prout, New York, N. Y.; Secretary, Francis Collingwood, New York, N. Y.; Treasurer, John Bogart, New York, N. Y.

COMING TECHNICAL MEETINGS.

MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19. Annual meeting at Lansing, Mich. Secy., F. Hodgman, Climax, Mich.

ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 21. Annual meeting. 1122 Girard St. Secy., L. F. Rondinella.

DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 24. Secy., Parker N. Black, Capitol Block.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 25. Annual meeting, Springfield, Ill. Secy., S. A. Bullard.

CENTRAL RAILWAY CLUB.
Jan. 25. Secy., S. W. Spear, Buffalo, N. Y.

INDIANA ENGINEERING SOCIETY.
Jan. 24, 25, 26. Annual meeting at South Bend, Ind. Secy., E. B. Vawter, Lafayette, Ind.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 27. Secy., C. H. McLeod, Montreal, P. Q.

WESTERN SOCIETY OF ENGINEERS.
Feb. 1. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF ST. LOUIS.
Feb. 1. Secy., Arthur Thacher, Odd Fellows' Building.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Feb. 1. Secy., F. Collingwood. 127 East 23d St., New York.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Feb. 3. Secy., E. K. Smoot. 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Feb. 3. Secy., O. Von Geldern, 719 Market St., San Francisco.

NORTHWEST RAILROAD CLUB.
Feb. 4. Union Station, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 4. Secy., F. D. Jones, Helena.

SWEDISH ENGINEERS' CLUB.
Feb. 4. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 6. Secy., C. L. Annan, City Engineer's Office.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 7. Secy., Chas. S. Howe, Case School.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Feb. 7. Secy., W. Halliburton.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 8. Wichita, Kan.

ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 9. Secy., F. W. Cappelen, 1023 Hennepin Ave.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Feb. 9. Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
Feb. 9. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Feb. 10. Secy., D. W. Meeker, St. Paul.

WISCONSIN POLYTECHNIC SOCIETY.
Feb. 13. Secy., M. F. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
Feb. 13. Secy., Waterman Stone, Baird Building.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Feb. 14. S. W. Spear, E. Buffalo, N. Y., Iron Works.

NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash

BOSTON SOCIETY OF CIVIL ENGINEERS.
Feb. 15. Secy., S. E. Tinkham, 36 Broomfield St.

NEW YORK RAILROAD CLUB.
Feb. 16. Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
Feb. 16. Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Feb. 16. Secy., C. F. Franson, Portland Block.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Feb. 17. 201 Washington Building.

WESTERN RAILWAY CLUB.
Feb. 21. Secy., C. F. Street, Rookery Building, Chicago.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Feb. 21. Secy., E. H. Clark, Pittsburg.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W. Raymond, 6 Burling Slip, New York, N. Y.

NEW ENGLAND RAILROAD CLUB.
March 8. Secy., F. M. Curtis, O. C. R. R., Boston.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

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The abortive auction sale of the rapid transit franchise occurred Dec. 29 last. Mr. Gould died Dec. 1. The course of prices of Manhattan and the other Gould stocks before and since these dates is at least interesting and possibly instructive. It is shown with substantial completeness in the following little table:

	Manhattan.	Mo. Pac.	W. Un.
Nov. 30	129	53⅜	86⅞
Dec. 5	133	57⅛	89½
" 17	133½	56⅜	94⅛
" 23	140	56⅜	92⅞
" 29	150	57	95⅜
Jan. 7	155¾	56¾	96¼
" 13	174¾	59⅝	98¾

These are in each case the highest quotations of the day. For some six months or more before Nov. 30 Manhattan had fluctuated but a few points either way from 129-133.

It will be seen that the notable advance immediately after Gould's death was confined to two of his three leading stocks, Missouri Pacific not showing it. The Western Union advance, though sharp at first, spent its force in a few days. Manhattan also advanced four points upon Gould's death, but thereafter remained steady up to Dec. 17, about ten days before the sale. Then, however, began a notable and sharp advance, rarely equalled by any investment stock in quiet times. In six days (one of them Sunday) the stock advanced 6½ points; in the next six days ending with the sale (one of them Sunday) it jumped 10 points more, or 16½ points in all. Thereafter it became steadier for a few days, but soon again advanced, and more sharply, to nearly 25 points above the price of the sale, and over 41 points above the price 10 days before the sale. This advance at the time (i. e., before the sale) was ascribed only to the effect of Gould's death; but it is evident from the preceding table that the only part of the advance which, with any show of reason, can be ascribed to that cause is the advance of four points between Nov. 30 and Dec. 5, no further advance occurring for 12 days. It is now generally admitted that all the recent advance is to be ascribed to the increasing prospect that the Manhattan Ry. will be granted much enlarged powers by the Rapid Transit Commission, and control the rapid transit of New York for many years to come.

But how did it happen that Manhattan showed such a sharp and great advance 10 days before the sale? Certainly the public actions of the Rapid Transit Commission were calculated to discourage rather than encourage such advance. The circumstances are worth considering. For more than a year prior to the sale the commission had shown a determined preference for the Broadway underground line, which it finally prepared plans for and advertised for sale. It expressly discouraged extensions of elevated lines. Nevertheless, its terms of sale made it practically impossible for any bona fide bidder who had not previously made himself solid with the powers that be to bid at all, for several reasons shown in our issue of Nov. 24 last; but it had full power under the law, and reserved that power, to readvertise the franchise under the same or different terms of sale. In fact, had there been no bid at the first sale it was obligated to readvertise it. But there was a bid, from a wholly irresponsible ex-employee of the commission, which was promptly rejected.

Then the commission, without waiting even decently to bury the other project, right-about faced within three hours; announced (Eng. News, Jan. 5) that the sale "demonstrated" that the commission "must immediately" adopt other plans; that the streets "must inevitably be invaded by new elevated structures," and that the commission will "proceed with this work at once." They also proceeded at once to conferences with the Manhattan officials, and made it tolerably clear that they intended to negotiate with no others. Ordinary prudence would have caused a commission zealous for the interest of the city to assume some hesitation, if they had it not, about so complete a change of front, in order to make the best possible bargain for the city. And ordinary pride would have led a commission thus compelled to confess error, to avoid overt confession as long as possible. But with these, ordinarily powerful motives were ineffectual, as also the thought that their course would be sure to cause a sudden jump in Manhattan and thus bleed the lambs of Wall St. Did any one know in advance what their purpose was? If so, what a "dead open-and-shut" he had! And what a "dead open-and-shut" he will have again should the commission discover, in an access of Roman virtue, that the demands of the Manhattan are inordinate and inadmissible, and take up its former plans again! We are not prophets, but we advise all our readers to be a little cautious about buying Manhattan on a margin.

Is there any good reason for using blind tires on some of the driving wheels of ten-wheel, consolidation or decapod locomotives? Certainly there ought to be, in view of the fact that the great bulk of such locomotives now running have been built with such tires; but according to a recent discussion before the New York Railroad Club, it is better to put flanges on all the wheels. We print this discussion, with such other data on the question as we have been able to collect, on another page, so that our readers may form their own conclusions. Doubtless engines with a long, rigid wheel base can be made to work successfully with all wheels flanged, if enough lateral play is given, and the parallel rods are loose enough on the crank pins; but on the face of it, it seems a better plan to keep all the driving wheels driven from one cylinder in good line. Because a consolidation engine with blind tires on both middle drivers goes off the track on a sharp curve, it does not follow necessarily that these tires had better be flanged; for if this were done, and the engine wheels were to take exactly the same course over the curve, the engine must either mount the rail or spring the truck or the track in her passage. Blind tires on a locomotive should be made as broad as clearance will permit, and should not have lateral play enough to permit them to fall off the rail on sharp curves.

Some interesting facts concerning the strength and reliability of copper steam pipes, which were developed in tests made by the Bureau of Steam Engineering, are recorded elsewhere in this issue. The results obtained are not such as to increase one's confidence in the safety of the ordinary brazed-seam copper pipes, which are in practically universal use on shipboard. It appears that the strength of a brazed seam is only about one-half that of the sheet from which it is made; and what is of much more importance, it appears that in the process of brazing the metal of the pipe may not only be, but in a thick pipe is quite certain to be, badly burned. The effect of this burning is seriously to reduce the tensile strength and ductility of the metal, and the character of its fracture is changed from fibrous to granular. As evidence that this is the common characteristic of a brazed joint the report says.

All the brazing was done by expert workmen, and their failure to make a pipe joint without burning the metal at some point makes it probable that with copper of this (0.238 ins.) or greater thickness it is seldom accomplished.

Notwithstanding this strong evidence of weakness and brittleness in brazed pipes, the writers of the report conclude that such pipes are, on the whole, safe enough. They reach this conclusion by reasoning that, as the minimum ultimate strength of the pipe, computed from the results of the tests, is four times the strain produced by the highest steam pressure, there is, therefore, little chance of the pipe's failure under normal conditions of service. The failures which do occur, they believe, are almost invariably due to seams so defective that inspection should have detected their weakness, or "to the presence of water hammer, against which no pipe is safe."

It is questionable, however, whether the question should be disposed of in so easy a manner. What assurance is there that this factor of safety of 4, supposing we can be reasonably sure of securing it when the vessel is new, will be maintained after years of service, during which the vibration of ship and engines has been, perhaps, gradually weakening the burned metal at the brazed seam? The tendency of modern engineering is more and more toward the substitution of certainty for uncertainty in every case where human life is at stake; and even though careful workmanship and inspection can reduce to a minimum the dangers from burst steam pipes, the fearful results of such explosions call for a larger factor of safety than 4, and a metal of greater reliance than over-heated copper, provided it can be secured.

Soon after the explosion on the "Concord," in our issue of June 20, 1891, we reviewed the various methods which have been proposed for increasing the safety of steam pipes on shipboard. Some of these have been put in service on merchant vessels with most satisfactory results. The fatality attending steam pipe ruptures on naval vessels, where every inch of space is utilized, and many ships are worked on forced draft with closed stokeholds, makes the prevention of such accidents on them of even greater importance.

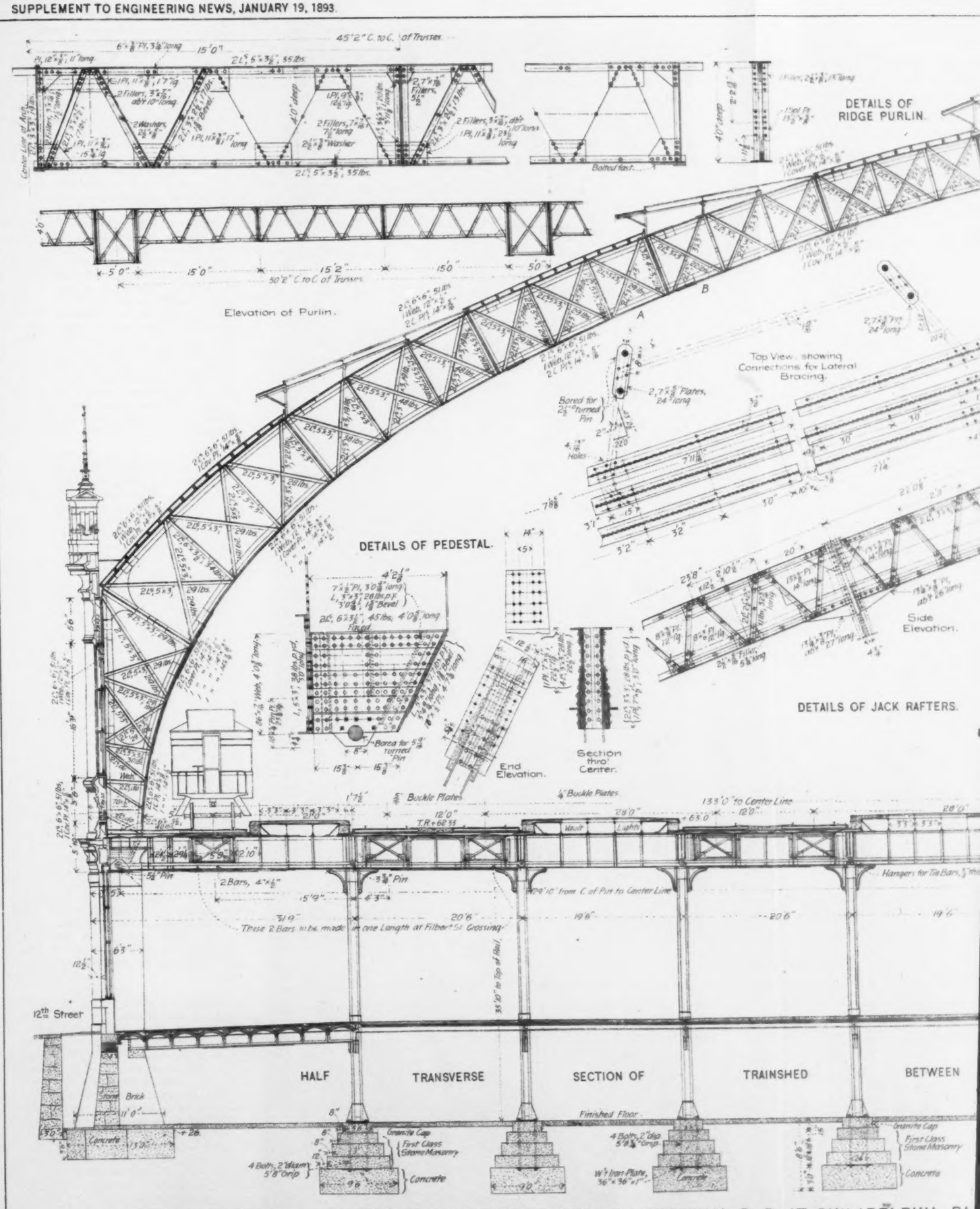
Important evidence regarding the extent to which disease germs and other bacteria may be removed from water by filtration has just come to hand from three different sources, mentioned below. All of the evidence shows that a large percentage of bacteria may be removed, so that the filtered water, compared with the same water without filtration, is relatively safe.

In the article published in our issue of Dec. 29, entitled "The Removal of Micro-Organisms from the London Water Supply," Prof. Percy F. Frankland states that during the three years 1886, 1887 and 1888 he made monthly biological examinations of the London water supply. As a result he found that in the case of water from the Thames River of every 100 micro-organisms present in the unfiltered water, 97.6 were removed by subsidence and filtration in the year 1886; 96.7 in 1887, and 98.4 in 1888.

In the report of the English Local Government Board for 1891-2 Prof. E. Frankland, in his yearly report on the examinations of the waters supplied by the Metropolitan Water Cos. of London, states that in March, 1891, of 33,238 colonies of microbes per cu. cm. of the intakes of the West Middlesex Water Co., only 56 remained after the water had been filtered, showing a removal of 99.83%. The Lambeth Water Co., said to have furnished the least efficiently filtered water of any of the Metropolitan companies, in March, 1891, showed a removal of 98.76% of the microbes of the unfiltered water. Prof. E. Frankland says in this connection:

> In this enormous reduction there is obviously a considerable, though by no means absolute, guarantee that pathogenic organisms, if present, would disappear with the crowd. Nevertheless, it is only by the rejection for dietetic purposes of water polluted by excrementatious matters that immunity from water-borne zymotic poisons can be secured.

Prof. Percy F. Frankland, in the article mentioned above, gives as his opinion that in the case of the combined subsidence and filtration practised at London much, if not all, of the harmfulness of the pathogenic micro-organisms present in the water is destroyed. In conclusion, he says that



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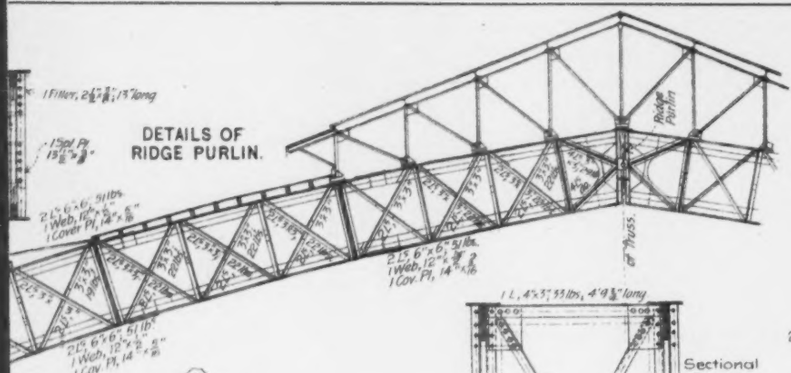

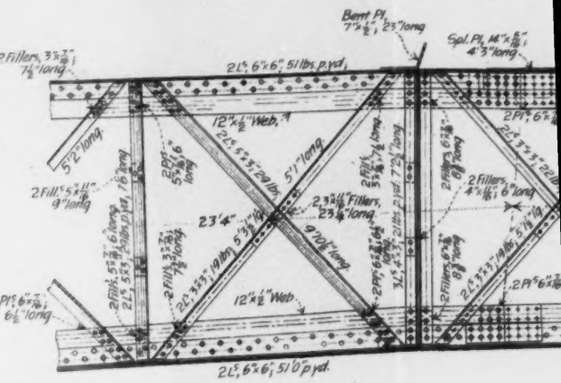

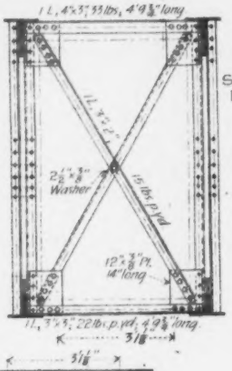

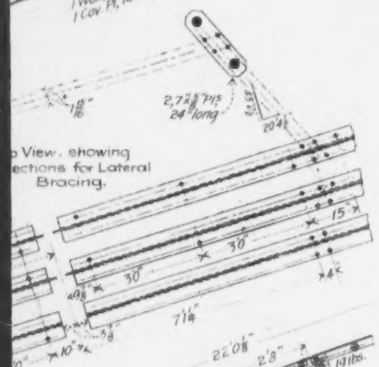

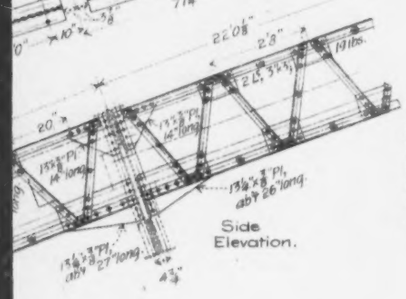

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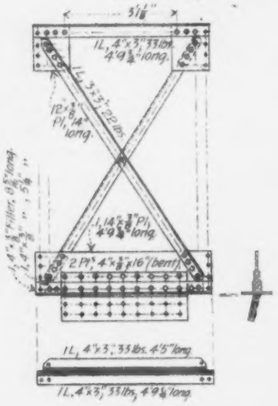

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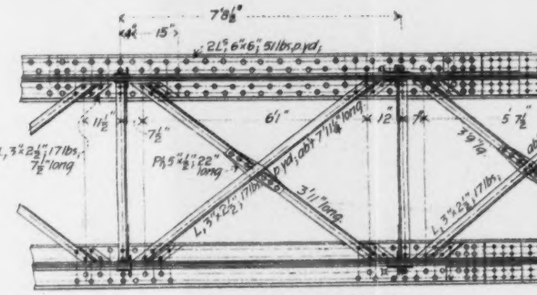

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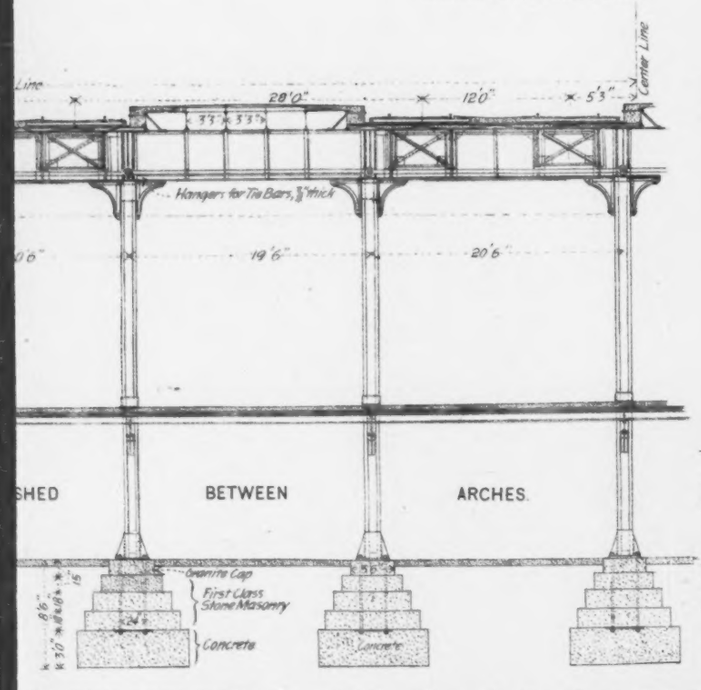

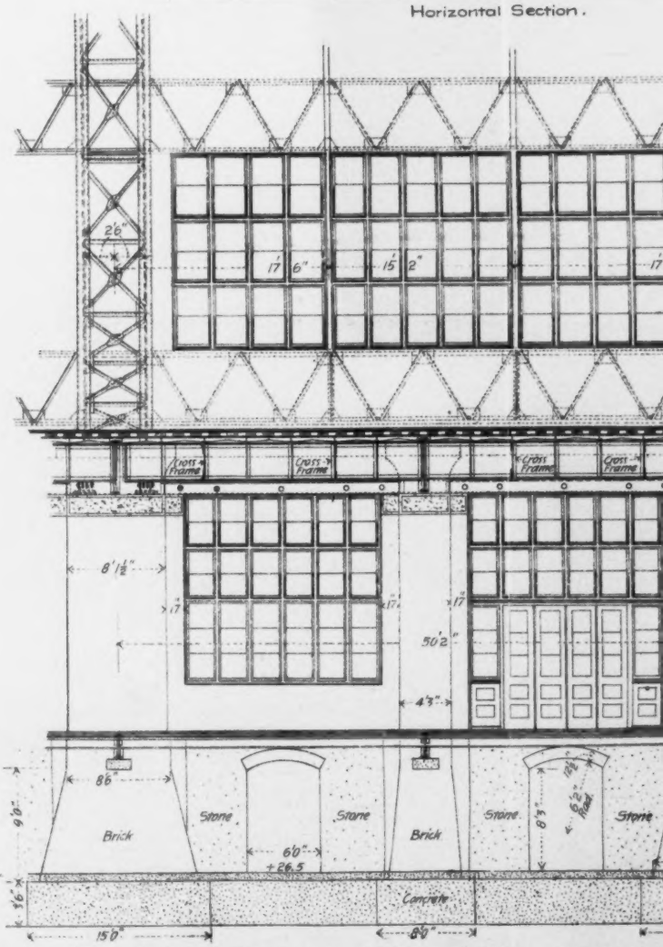

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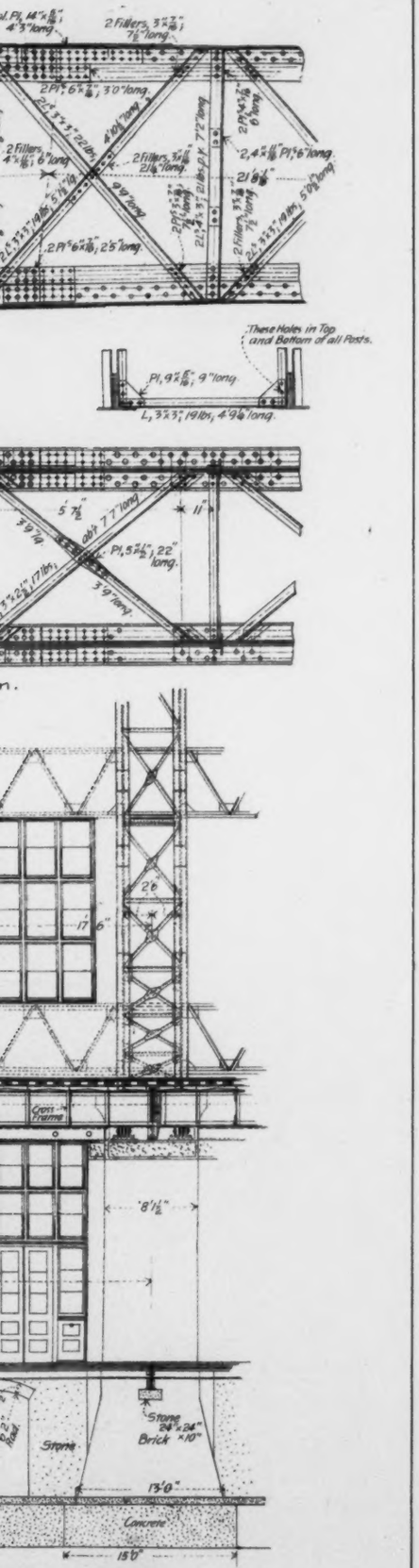


R FOOT OF ARCHES.

onzano, Chief Engineer.

CHAS. HART & SONS, LITH, 25 VESEY ST., N. Y.

theoretically mischief from these organisms may not be absolutely impossible, and that "it is for statistics and experience to prove that it does occur."

In connection with the above results obtained in actual practice, it may be noted that experiments on the filtration of water through sand made at the Lawrence Experiment Station of the Massachusetts State Board of Health (report for 1891) show a very high percentage of bacteria removed from ordinary river and canal water. Of the bacteria in the effluent water careful studies give reason for believing that most of them develop in the underdrains, while it is probable that they are entirely harmless. In addition, cultures of the typhoid bacillus and other more easily recognizable bacteria have been applied to the experimental filters, and in many cases entirely removed from the applied water; when not completely removed they have been nearly so, except in one or two instances. The Lawrence experiments are reviewed at length elsewhere in this issue. While it may be urged that the Lawrence experiments have been conducted with a degree of care that could not be expected in the actual filtration of water in large quantities, nothing can be said against the London results, for there immense volumes of water have been filtered. Besides, given a carefully prepared filter bed its proper superintendence and operation are extremely simple, although chemical and biological examinations of the water should be made with as great frequency as circumstances will permit.

The lowest depths yet in the Panama Canal scandal have been touched this week. M. Eiffel, the greatest of French engineers, now stands convicted out of his own mouth as the meanest and most monumental swindler that even the Panama investigation has brought to light. Among other things, he confesses to having drawn $2,400,000 for machinery purchased, when he had only expended in fact $300,000; to having paid on his own account for influence in his own favor $400,000 each to M. Hebrard of "Le Temps" and to Baron de Reinach; to having collected $575,000 as a "percentage" on an order which was never executed at all, and to sundry other minor swindles of the kind. In all, according to the face of his and the company's books as reported by the government accountant. M. Eiffel was paid $13,800,000, and only expended $7,200,000, leaving, as his apparent and visible profit $6,600,000. How much further allowance is to be made for contemporaneous and subsequent doctoring of the books can only be guessed at; but it appears quite certain that a large allowance of this kind is called for to make even an approach to the real facts.

When we consider that, when he did these things, M. Eiffel's prior brilliant career had not only brought him world-wide fame, which should have made his good name precious to him, but great fortune as well (the Eiffel tower alone having been enormously profitable), the degree of depravity indicated by his conduct is quite beyond parallel in the annals of industrial enterprise. And when we further consider that most of the prominent statesmen and editors of France joined in the same thieving game, so far as they had a chance, and that, as yet, the name of but one man is in evidence (M. Leroy-Beaulieu) as one who could, but did not, join in it, the record goes far to justify the worst impressions of the present moral status of the French governing class.

One cannot but question in the face of such revelations of wide-spread corruption in high quarters, and of the similar corruption which the Franco-Prussian war revealed in 1870-71, whether the existing military administration may not also be honeycombed with corruption, which the next great war will reveal with disastrous results to France. It behooves the French to know this; and if they cannot do both at once, they would be far wiser to turn the search-lights of investigation in this direction, while there is yet time, rather than to concentrate effort upon what is now past all effective remedy. Never was the need for a free press in a free country better illustrated than by these occurrences. It may be thought that the intense patriotic feeling of the French, and their desire to win back their lost provinces and lost military renown, gives a special protection against military corruption, but such is not the case. Granting what we believe to be true, that if the issue were distinctly placed before him, there is hardly a living Frenchman who would not surrender not only chance of profit, but all he has and even life itself rather than see France defeated; such is not the real issue. On the contrary, each particular man thus tempted may say to himself with perfect truth that his particular peculations, however great for an individual, are merely a drop in the bucket in any case. If he is only one of thousands of others, he alone can do no good by being too honest. If he is the only one who is not honest, still less will it matter. Only thus can the frequent concurrence of individual rascalities with supreme national efforts be explained. Not one in a hundred of the rascals but would turn from illicit profit in horror if the distinct issue were the surrender of that profit or his country's ruin; and yet, if such private peculations go far enough the result is the same as if each one of them were ready to sell his country for that profit. Is it so to-day in France? Germany will take great pains to know, we may be sure, whether France does or not. According to some earlier and more detailed charges made before the governmental commission, Mr. Eiffel ceded his big contract for lock excavation to another party at a 50% profit, and this party ceded it to a third contracting firm at 25% profit. The liquidator of the Panama Canal Co. has presented to the Civil Tribunal a report showing that where the average cost of excavation on the canal was $2.20 per cubic meter, Mr. Eiffel was granted a contract at the rate of $6 per cubic meter. As to other contractors, it is charged that one firm received payment in full for excavating 2,800,000 cu. m., where only 1,600,000 cu. m. had been actually removed, and another company dug out 4,500,000 cu. m., and was paid for 8,400,000 cu. m. With this showing it is little wonder that the canal enterprise was a failure.

The rapidity with which the electric motor is displacing other methods of traction on street railways is not fully realized, even by engineers. Five years ago the electric railway was an experiment, and in the whole United States but 50 miles of street railway was operated by electricity. At the present time trolley cars are running on street railways aggregating about 6,000 miles in length, a greater mileage than that of the street railways operated with every other kind of motive power, including animal power. This progress has been made by an acceleration somewhat comparable to that of a falling body; and of the total mileage in operation, nearly one-third was built during 1892.

Of course a large part of the electric railway mileage consists of lines formerly operated by other motive power; but the impetus to the building of new lines for city passenger traffic, and perhaps still more for suburban lines, which has been due to electric traction, has been enormous. In July, 1890, the street railway mileage of the country was 8,650 miles. At present the total mileage is 11,655 miles, an increase of 3,000 miles in 2½ years. The increase during 1892, according to the table published on page 31 of our last issue, was 1,066 miles, a figure which represents an enormous gain in the transit facilities of American cities.

From these figures the evidence appears to be strong that the electric motor is destined to supplant animal power on a very large proportion of our railways which are still operated by horses or mules. Whether it will be able to obtain sole possession of the field is less certain. On many lines of very thin traffic, cars run by animal traction or by some form of independent motor may prove, on the whole cheaper than the trolley or conduit system, and some form of gas, steam or compressed air motor may yet be able to compete with the trolley on its own ground. On roads with undulating or very steep grades and few curves, as well as on roads of the heaviest traffic, the cable system still holds its own.

In discussing the subject of good roads, Governor Flower, in his last annual message, says that from statistics gathered it is shown that 50 counties of the state of New York annually pay, in labor and cash, about $2,700,000 for work upon highways. This is about $54,000 for each county, and it is very safe to say that the larger proportion of this large expenditure is absolutely wasted under existing practice.

Governor Flower is opposed to the establishment of a national bureau or department of roads; and so far as the consequent building of public roads by the national government is concerned, we agree with him fully. But, as we have before mentioned, there is a field for action by the government at Washington that could be cultivated with benefit to the nation at large. That is the systematic, intelligent gathering of road statistics throughout the United States and abroad. The work done in this direction by American consuls in foreign countries fails of permanent value in being the work of non-professionals. To teach the American people that others have advantages that they have not, every effort should be made to first point out in the most forcible and complete manner the exact status of road affairs at home, in each individual state, and later to show where and how the disgraceful existing state of affairs can be improved. The gathering and proper preparation and dissemination of this information is an eminently fitting work for a government bureau, commission or whatever it may be styled.

But the actual performance of the work should be left to the state, to be carried out as resources, local conditions and self-interest may dictate. And no state will act efficiently in any direction until the people, who elect the lawmakers and pay the bills, themselves understand the personal and pecuniary gain of better methods in road construction and maintenance. To repeat, the present is an educational campaign., and in this direction the national government can do valuable work.

We omitted to call attention, in our reprint of "Industries" article on exports of American locomotives (Eng. News, Dec. 22, 1892,), to the fact that the figures given by that journal were absurdly incorrect, the United States being credited with an export of 8,815 locomotives in 1891, which was about 45 times as many as the number actually exported (197). The "Railroad Gazette" very justly calls attention to this omission, the occurrence of which we are quite at a loss to explain, save that the member of the staff who prepared the article was suffering from temporary aberration; and although formerly engaged with the Baldwin Locomotive Works and familiar with the locomotive export trade, he did not stop to grasp the details of "Industries" preposterous statistics, the purpose of the article not being statistical.

The actual facts concerning locomotive construction are that the total construction in the United States is some 2,000 to 2,500 per annum, which is on an average somewhat more than half of the total production of the world.

THE LETTING OF HIGHWAY BRIDGES.

While the present practice of letting contracts for highway bridges is sanctioned by many years of use and abuse, the resulting evils, recognized by both buyer and seller, would seem to demand some radical reform. Existing methods leave the selection of plans and fixing of prices in the hands of men unfitted by training to render a just verdict based upon merit alone; and the conditions which have grown up with the sharp competition among bridge builders necessarily adds to the cost of the structure an "expense bill," outside of the cost proper, which must be paid ultimately by the buyer.

We freely recognize the fact that there is little immediate probability of remedying present evils of this sort by legislation, for there is no "politics" in bills of this sort; and the engineers and bridge builders who are alone familiar with the facts and able to frame proper legislation upon it cannot do so without being accused of furthering their own interests, an accusation fatal to the success of any measure which has neither politics nor plunder behind it.

But even without legislation, can engineers and bridge builders, by co-operating with each other, do anything to remove the abuses and defects of the present system of bridge construction? To properly consider this question let us see what these abuses are. A highway bridge is to be built

in a country town, and after more or less discussion in the newspapers and a controversy over its location, etc., a day is set when the bids will be received. Sunrise on that day will see a dozen or more representatives of bridge companies on the ground, some of whom may have been for several days devoting themselves to cultivating the acquaintance of the officials in charge of the letting, as well as of any other prominent men whose influence may be worth having. Perhaps some of these early birds are able to make themselves so "solid" with the powers that be as to literally defy competition. Perhaps, on the other hand, the men in charge of the letting are strictly honest and unapproachable; in that case the "boys" may have a quiet meeting and strike off the bridge to the highest bidder. The fortunate party adds the amount he must pay to buy off the competitors to his bid, and the others put in dummy bids for higher amounts.

It is wrong to assume that these methods of doing business are relished or liked by bridge manufacturers; but they are forced upon them by the circumstances of the case. Their practical result is that the town or county pays an exorbitant price for a bridge, and only a very small proportion of this goes to the bridge builder as profits. Even allowing a perfectly straight transaction throughout, with no payments of pools or commissions, the expenses attending the sale of a bridge costing say $5000 to build and erect may foot up about as follows:

Twelve agents, traveling and hotel expenses and general entertainment funds, say $50 each.....	$600
Preparation of blue prints, designs, estimates, etc., at $25 each company.....	300
Bridge works' profit on cost of bridge, say 15% on $5,000.....	750
Commission of selling agent, same.....	750
Total.....	$2,400

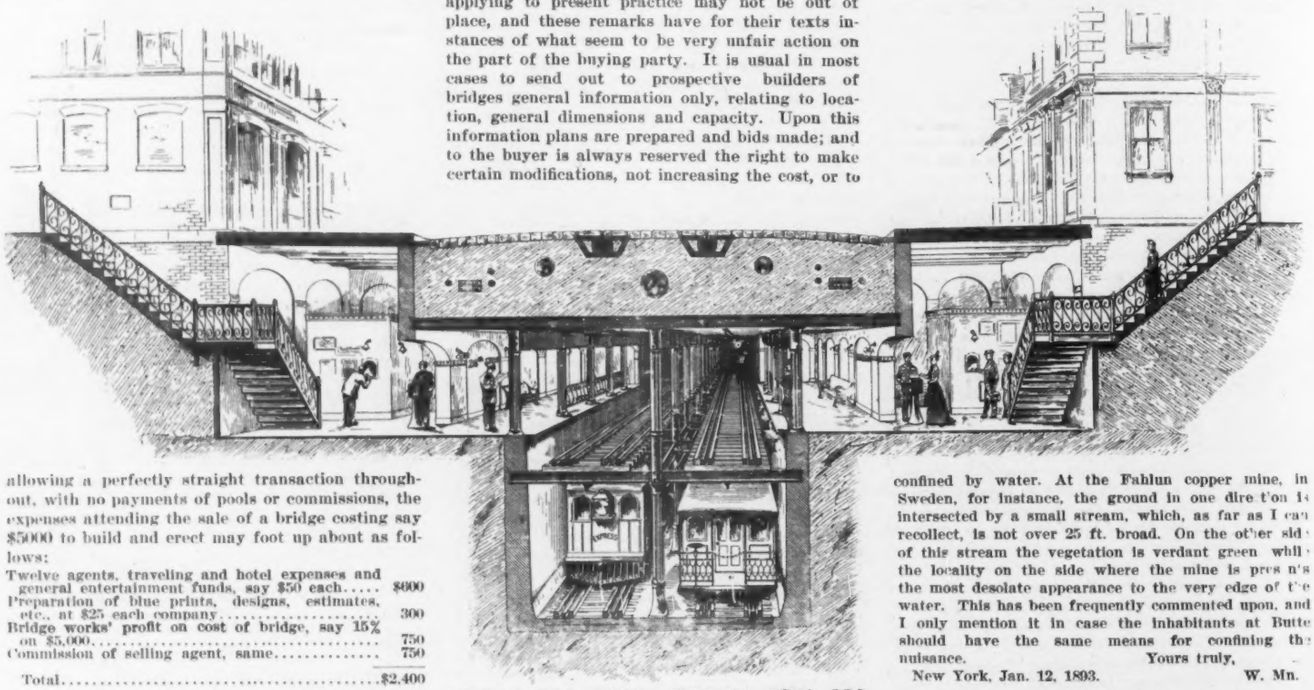
Where pools are formed or commissions are paid the price which is paid for the bridge in excess of its cost of manufacture may be even larger. But leaving these notoriously common transactions quite out of account, it is plain enough that the cost of good highway bridges, notwithstanding the low prices of material and shopwork, is kept up to a point which considerably checks their construction and fosters the use of wood and combination structures which are more expensive to build, although cheaper to buy.

Now let us suppose that the commissioners in charge of a bridge letting, wishing to obtain a good and safe bridge at a low price, employ a competent and reputable engineer who is familiar not only with the principles of bridge construction, but with the practice of bridge letting, and knows what work of the class desired ought to cost. Such an engineer will refrain from making his own designs for the structure in question, but will prepare full information, enabling the competitors to judge closely of the cost and risk of erection, specifications defining closely how good a structure is required and nothing more, and will require all bids to be sent in by mail, either forbidding the presence of bridge companies' representatives, or else restricting the bidding to a few selected firms of good reputation for reliable work and moderate prices.

With such a method of letting bridge contracts, present heavy expenses attending these lettings, which the taxpayers must foot in the end, would be avoided, and the engineer could do a service which the honest buyer and seller would alike appreciate. Is such a revolution too great a one to be hoped for? Could a sufficiently great reduction in cost be thus effected to make the public recognize it as the best and most just method? We are by no means sanguine in the matter, yet it seems beyond question that an opportunity is open here for effecting an important reform.

If the engineer cannot in some such way as we have outlined reduce the cost of highway bridges, we fear that his employment by purchasers of such bridges will continue to be, as it is now, very infrequent. With iron and steel at their present low prices, there is so little to be gained by reducing sections and weights of metal that we believe, with possible rare exceptions, the iron highway bridges now being erected are at least reasonably safe. If the engineer is not required on the score of safety, then the only reason for employing him is to economize cost, and we have pointed out above how he can do this to the advantage of all parties concerned.

While on this subject a few words of advice applying to present practice may not be out of place, and these remarks have for their texts instances of what seem to be very unfair action on the part of the buying party. It is usual in most cases to send out to prospective builders of bridges general information only, relating to location, general dimensions and capacity. Upon this information plans are prepared and bids made; and to the buyer is always reserved the right to make certain modifications, not increasing the cost, or to allow an equitable sum for additions which increase the cost. But in no instance should a high bidder be permitted to modify his plan or price after bids are once opened; and the equitable rights of the lowest responsible bidder should be recognized when minor modifications of plan are in question which do not increase his price beyond that of the next highest bidder. While the right to reject "any and all bids" should still be exercised in cases of evident collusion among bidders, this clause should not be used, as is too often the case, simply to promote the interests of a local competing firm, to the injury of other responsible bidders. The rights of the lowest "responsible" bidder are usually coincident with the true interests of the county or town buying the bridge, and any action contrary to this rule must be based either upon dense ignorance of the merits of competing plans and prices, upon improper favoritism, or upon corruption by the party to be favored. No honest official can afford to find himself too near this three-horned dilemma. We shall be glad to give space for discussion of this subject by the bridge builders and engineers who are interested in this matter.



STATION FOR LOCAL TRAFFIC; RENO PROPOSED DOUBLE-DECK TUNNEL FOR NEW YORK RAPID TRANSIT.

LETTERS TO THE EDITOR.

FAST TRAINS.

Sir: Will you kindly inform us through Engineering News what is the fastest time ever made by a railway train of any description for a short distance, and under favorable circumstances; and also for a long run of several hundred miles. Also, whether there is to-day, or ever has been, a regular train scheduled for faster time than that of the Empire State Express of the New York Central & Hudson River R. R. We appeal to you to settle a discussion, and we shall be grateful to you for an answer. Yours, etc.,

Dayton, O., Jan. 4, 1892. J. McLain Smith, Jr.

(The fastest speed ever attained by a railway train was a mile in 37 seconds on Nov. 18, 1892, being at the rate of 97.3 miles per hour. Details of this run, and a general discussion on the question of fast trains were given in our issues of Dec. 8 and 22, 1892. The Empire State Express is undoubtedly the fastest regular train in the world, and the great length of its run makes it especially notable.—Ed.)

THE SULPHUR FUMES FROM THE BUTTE SMELTERS.

Sir: With reference to the sulphur smoke nuisance at Butte City, mentioned in your issue of Jan. 5, I would say that it seems as if the smoke could be confined by water. At the Fahlun copper mine, in Sweden, for instance, the ground in one direction is intersected by a small stream, which, as far as I can recollect, is not over 25 ft. broad. On the other side of this stream the vegetation is verdant green while the locality on the side where the mine is presents the most desolate appearance to the very edge of the water. This has been frequently commented upon, and I only mention it in case the inhabitants at Butte should have the same means for confining the nuisance. Yours truly,

New York, Jan. 12, 1893. W. Mn.

SOME ADVANTAGES OF A DOUBLE-DECKED RAPID TRANSIT TUNNEL UNDER BROADWAY.

Sir: The reopening of the discussion of the New York rapid transit problem consequent upon the failure to sell the franchise for the four-track level tunnel recommended by the Commission has led me to request space in your valued journal to mention some of the advantages of the Reno tunnel system (Eng. News, Feb. 27, April 2 and 21, 1892) in its application to Broadway, and at the same time to answer the objections made by the Commission to the double decked tunnel. In its final report the Commission has stated that it would be "loth" to recommend a form of tunnel which did not permit of a use of the adjacent local track by the express trains, and vice versa, so that in the event of an accident to any train the traffic upon the blocked track could be switched over upon the adjacent one. I think the importance of this feature has been magnified, for it is improbable that an accident of a serious nature could occur upon any one track in the tunnel without causing such damage to the adjacent track as to make it impossible to run trains upon it immediately. The experience of the elevated roads has shown it to be possible to guard very effectively against all traffic delaying accidents except those caused by burning buildings, and, of course, a tunnel would be free from accidents of this kind. The Rapid Transit Commission has also made objection to the double decked tunnel because of the fact that the tracks of the local system are carried upon steel beams instead of upon the ground, and it has been pointed out that this steel structure is not suitable for heavy trains run-

ning at high velocities. I think a consideration of the conditions to be met in the local traffic of the tunnel will show that it will be impossible to attain high train speeds with the stations only about one-quarter mile apart, and that as far as the weight of the local trains is concerned it will be found of great advantage both in economy of operation and in a saving of time in stopping and starting to have them as light as possible and to consist of a less number of cars each than would compose the express trains. The public will be better served by short and light local trains which can be started and stopped quickly at the stations, and which consequently could follow one another at short intervals than by the same number of cars distributed in longer trains and following one another at long intervals. On the other hand it will be seen that in the double decked tunnel the heavy express trains, with the stations a mile or more apart, can attain a high speed and are provided with the most substantial form of roadbed, and, furthermore, this roadbed will be so far removed from building foundations as to communicate no vibrations to them.

In its report the Rapid Transit Commission has objected to the fact that in the double decked tunnel it will be necessary for passengers to make an additional climb of about 12 ft. between the express and local platforms. This, however, would only be necessary at the ten express stations, and at these points the Reno continuous elevator (Eng. News, Aug. 25, 1892), could be used. As shown by the continuous elevator now in operation this machine can handle 150 passengers per minute, which is a much greater capacity than would be required in this case.

The Broadway cable road has constructed at Houston St. a large wheel pit 28 ft. in depth, extending from the center of the street westward to the power station, and the drawings of the Commission's engineers show a three-track tunnel dipping beneath this obstruction while the fourth track is shown in a separate tunnel at the east side. With the double decked tunnel this complicated, not to say impractical, construction will be unnecessary, because as there is sufficient space to the east of the wheel pit to contain a tunnel of this form it will only be necessary to curve it horizontally at this point without increasing its distance below the surface.

In an editorial in the Engineering News of recent date it was pointed out that the proposition of the Commission to concentrate the east and west side tunnel traffic into one tunnel at Union Square would probably lead to serious congestion. In addition to this objection the complicated and costly construction proposed at Union Square is out of all proportion to the importance of the short branch tunnel extending to 42d St. As the extension of Elm St. will soon be under way, giving practically a continuous thoroughfare from the City Hall to Fourth Ave., it would seem advisable to separate the traffic of the east and west sides by carrying a tunnel under this new street and Fourth Ave., which could be operated in connection with the New York Central R. R. system.

The tunnel recommended by the Commission requires a complete change in the sewer system of Broadway, which alone, because of the network of pipes, electric subway and other structures, will prove a very costly preliminary to the work cannot be accomplished without an extensive disturbance to the street surface. In addition to this will follow the disturbance due to the underpinning of building foundations and the subsequent construction of the tunnel sidewalk, all of which will be unnecessary in the Reno tunnel system.

I would call attention to the accompanying engraving as showing the simple construction of the local stations, the economic importance of which will be appreciated when it is stated that there are no less than twenty-six of them required. The reader will note that passengers at those stations will not be subjected to the unpleasant sensations experienced when an express train thunders by on the same level, as would be the case in the Commission's tunnel.

The tunnel of the Baltimore Belt R. R. recently completed in ground of similar character to that under Broadway has given such evidence of the creeping in of its floor that an invert has been found necessary. The extent of invert required by a four-track level tunnel under Broadway may be imagined. J. W. Reno.

New York, Jan. 16, 1893.

SEWER RECORDS.

Sir: Current discussion on sanitary science and sewerage having led off from the various details of design and construction of sewerage systems to speculative fields regarding the value of sewer systems during epidemics, or their economic value to municipalities, little has been said of the subsequent management and extension of sewerage systems as regards the engineer's work.

In this city (Dallas, Tex.) much work has been entailed upon the engineering department in connecting up and extending the original sewer system by reason of the lack of records. That this is general in municipal work I have noticed in visits to other cities, and by notes in the engineering journals, at different times, regarding the work and responsibility encountered by newly elected city engineers in various places.

Engineers on construction, in general, being assistant engineers in the city engineer's department, have manifold duties to perform in one day, in connection with the superintendence of laying the sewers, with estimates and bad ditches to look after on rainy days; and that they are not every time blamable is evident. The notes taken on their rounds, not always complete for that day, are filed away, and the engineer, usually not being associated with the later work of that department, is not on hand to interpret them when referred to, or, oftentimes, landmarks referred to are gone, when the notes are exhumed, and they become practically valueless.

In preparing a summary of construction work and completing the records of several miles of sewers laid here in the past four years I have worked from the notes of some fifteen or more engineers, and the various forms to contend with have suggested the ideas herein set forth. Preliminary levels are taken over the route of sewer for profiles, estimates, etc., preparatory to letting the contract, upon the usual form of level book, and marked "preliminary," with date of same. In staking out and taking notes on the work I have found the following form most convenient:

Taking notes on this form gives ample time to "keep an eye on the rodman" when staking out the work and make subtractions later, and also leaves space for such notes as are usually taken on the work.

Sewer in block 77, from Akard to Ervay St., April 7, '92. L. 0—0 R.

F. O. Brown, contractor.

Sta.	+ s	H. G.	Rod.	Elev.	Grade.	Cut.	Specials.	Remarks.
B. M.	5.48	113.10		107.92	....	....	....	Hydrant cor. Main and Akard.
0	...	.....	6 70	106 70	96.80	9.9	Manhole	Cen. Akard 96 ft. s. of S. L. Main.
+ 30	....	.....	....	.....	....	....	.....	E. L. Akard—brick building line.
+ 30	....	.....	....	.....	....	....	.....	97.50 El. Rock, beg.
				Rate, 1.10				April 12, 1892. Brown Dr to City for 6 pieces 6-in. pipe loaned.
+ 50	....	.....	7.30	106.10	97.50	8.6	.....	Crossing of old 4-in. sewer.
+ 55	...	.....	....	.....	....	....	3 Y L	Sewer line 4 ft. N. of E. & W. line of block 77.
+ 78	...	.....	....	.....	....	...	3 Y R	
+ 86	....	.....	....	.....	....	....	3 Y L	
1	....	.....	9.20	104.20	98.20	6.0	.....	98 50 El. Rock, end.
+ 15	....	.. ...	....	.....	....	....	3 Y R	
+ 33	....	.....	....	.....	....	....	3 Y L	
+ 50	....	.....	9.50	103 90	98.90	5.0	.....	
+ 66	....	.....	....	.....	....	...	.....	Fence line = E. L. Harry Bros. Bld'g.
T. P.	....	.....	6.65	106 75	....	...	.....	Top of ret. wall rear Scoll rd 6th St. Bld'g.

For office records various forms have been in use or on trial in this office. Previous to 1890 separate plots of each sewer as laid were made by the engineer superintending the same, showing Y's., etc., and these filed; but in this way the plots were oftentimes mislaid and lost, so that such information was scattered. In 1890 sectional maps of the city were begun on a scale of 100 ft. to the inch under the direction of this department, and upon completion of each such information as was at hand was entered thereon. These maps are made about 40×50 ins., on heavy mapping paper, and kept in a flat case easy of access, so that much information as they show can be found at once. It has been found to be a very convenient method for reference. The elevations and grades are shown on the profiles of streets when possible, and profiles of the line made, when in alleys or private property.

Another form which is most convenient for the many uses to which sewer records will be put is to make profile and location of sewer, to convenient scale, on regular profile paper, from the notes in the level book described above.

Each line requires special study to devise the most intelligible form, especially so when the line shifts and turns as it usually does in alleys or through private property.

I have suggested these few ideas hoping that other readers will make mention of methods which can be used to even better advantage.

Frank E. Snyder, Assistant City Engineer.

Dallas, Tex., Jan. 2, 1893.

AMERICAN GOODS IN FOREIGN MARKETS.

Sir: I have read with much interest an editorial article in the Dec. 15, 1892, number of Engineering News on the extension of our export trade. While the effect upon the future of this trade by probable tariff changes remains to be seen, there is no doubt that at present a growing tendency exists to seek foreign outlets for American products. Being in a position to mark in some degree the progress of this movement, I trust that you may consider acceptable and timely a few observations that I would like to make regarding it.

One serious drawback to the more general introduction of American products into foreign markets is to be found in the almost uniformly bad packing of American shippers. This may seem to be a trivial matter, but in point of fact it is one of great importance. Setting aside the loss to the shipper from breakage which he has to make good at his own expense, the unfavorable impression made on the mind of the purchaser from the slovenly appearance of the packages, and the loss of time incurred by him while breakages are being replaced, cannot but go a long way in deciding his preference for European made goods. I think I can say positively that, class for class, European goods are invariably better packed than American ones. This matter is one easily rectified, and at small additional expense in the first instance, while the saving in the long run from absence of breakage, which must be made good, not to speak of the effect on new markets, points clearly to the wisdom of assuming this small extra trouble and outlay at the start.

Again, it appears that American manufacturers are more averse to making changes in shapes and dimensions to suit foreign customers than are the Europeans. Here the problem is a rather more complicated one, for, as you have well shown in another part of the issue referred to, the fact of working upon fixed patterns enables American bridge builders to take a single instance—to contract for prompter deliveries than the British builders can. Probably what is wanted here is a more enlightened policy on both sides. Let the purchaser understand that his orders can be filled more quickly by accepting market patterns, and let the manufacturer realize that a little concession to what he may deem ignorant prejudice is frequently wisdom on his part.

I think that the greater cheapness of many European goods is due to the fact that their manufacturers base their operations more upon the securing of a large volume of trade than upon a high percentage of profit. This fact probably explains many seeming paradoxes.

When American concerns send agents to foreign countries to solicit or execute business, they should employ first class and experienced men for the purpose as they are likely to find foreign interests represented by such, and business capacity of the agent may frequently outweigh merit of the goods.

No doubt, in some of the South American countries, where growing demands are inviting the competition of American skill and ingenuity, honest firms are at a disadvantage from unscrupulous methods practised by others of manifesting and entering goods at the custom house. Let American houses, however, maintain their integrity in this and all other respects, and when they enter a new market let them do so upon a square business basis. A little firmness in this will put their future transactions upon a surer footing.

To summarize: If American manufacturers wish to grapple seriously with foreign markets, instead of merely toying with them, let them employ able men to represent them, and to study the market and its idiosyncracies; experts, in fact, who are capable of shaping requirements as well as meeting them. Let them ship first class goods in first class order, and live up to the letter of their agreements. To this I may add, last not least, let them take heed whom they deal with, as it is sometimes easier to sell than to collect.

Yours, etc.,

E. Sherman Gould.

Havana, Cuba, Jan. 6, 1893.

(Mr. Gould's position as Resident Consulting Engineer for Runkle, Smith & Co., American contractors for the new Havana Water-Works, together with his long residence abroad in other capacities, has given him exceptional opportunity to understand the situation which he discusses; but it is only fair to recall the fact that the charges of bad packing, disregard of the tastes of foreign markets, etc., are also stock charges against the British manufacturer.—Ed.)

NOTES AND QUERIES.

E. D. W., Chicago, Ill., asks for the names and addresses of manufacturers of ash sifters, suitable for use in separating ashes from garbage in crematories.

The outcome of the National Ship Canal Convention at Washington, D. C., is a resolution to be presented to Congress declaring that every consideration of national security, prosperity and honor demands the construction of a waterway not less than 20 ft. deep connecting the great lakes with the sea through American territory. The same resolution earnestly asks the prompt passage by Congress of House Bill 288, appropriating $100,000 and authorizing the Secretary of War to make surveys and estimates of cost of the various practicable routes for such waterway. Efforts were made at the same convention to push the claims of the Hennepin Canal and of the Ohio River and Lake Erie Canal.

BURSTING TESTS OF COPPER STEAM PIPES.

The report of Chief Engineer Geo. W. Melville, head of the Bureau of Steam Engineering of the Navy Department, records an interesting test of copper steam pipes made at the New York Navy Yard. The order for the tests followed closely on the disastrous explosion of the main steam pipe on the United States gunboat "Concord" in June, 1891. The record of the results obtained has just now been made public. Their principal object was to determine the influence of banding on the bursting pressure of copper pipes; and the bands were placed so far apart on the pipe tested that practically no information of value as to the effect of such bands was obtained. Some interesting things were learned however, concerning the reliability of brazed seams in copper pipes.

The following was the general method of conducting the tests: Each pipe was of 8 ins. diameter inside, and 3 ft. 1⅝ ins. long. Both ends were closed by ribbed heads, and the pipe was subjected to a hot water pressure, which was gradually increased until rupture occurred, the temperature being maintained constant at 371° F. One of the pipes was banded with 2×⅛-in. wrought-iron bands, spaced about 9 ins., c. to c., thus leaving a space of some 7 ins. between bands wholly unsupported. As might have been expected, failure occurred between the bands when this pipe was tested.

Three of the pipes were made of No. 4 sheet copper ("Stubbs'" gage) and the fourth was made of No. 3 sheet. If, by "Stubbs' gage" Birmingham gage is meant, this corresponds to 0.238 in. and 0.259 in., respectively. The rupture of the four pipes occurred at the following pressures per sq. in.: 835 lbs., 785 lbs., 950 lbs., 1,225 lbs.

Pieces of the ruptured pipes were also subjected to various mechanical tests. We reprint the following from the general discussion of results accompanying the report, made by Chief Engineer S. L. P. Ayers and Assistant Engineer F. H. Conant, U. S. N.:

The tests of specimens cut from the ruptured pipes show the injurious action of heat upon copper sheets; and that, while a white heat does not change the character of the metal, a heat of only slightly greater degree causes it to lose the fibrous nature that it has acquired in rolling, and a serious reduction in its tensile strength and ductility results. When it has undergone this change the fracture is invariably square to the plane of the specimen, and the metal has a granular, and in aggravated cases, a crystalline appearance; while, in its normal condition, the metal always fractures in a plane inclined at about 45° to that of the specimen, and displays a fibrous, silky nature.

A temperature considerably below a white heat is all that is necessary in making a brazed joint; yet, in all of the tested pipes, the fractures were square and granular, thus giving positive evidence that the metal, at least at the point of rupture, had been burned. That this was not the only point at which it had suffered, was demonstrated by the test specimens cut from the pipes, many of which broke with this characteristic fracture. Many of the specimens that were brazed separately had also undergone this change. All the brazing was done by expert workmen, and their failure to make a pipe joint without burning the metal at some point makes it probable that, with copper of this or greater thickness, it is seldom accomplished.

That it is possible to make a joint without thus injuring the metal was proven in the cases of many of the specimens, both of those cut from the pipes and those made separately, which broke with a fibrous fracture.

The trouble lies in the fact that the coppersmith, in making a joint, adjusts his heat by observing the glow and the freedom with which his spelter runs on the inside of the pipe. While these are sufficiently accurate indications of the temperature existing at the inside surface of the pipe, they may be delusive in regard to the temperature at the outside surface. In the fracture of many specimens the metal was granular through only a portion of its thickness, and always on the side that had been exposed to the fire, showing that this side had been burned while the other side had not. For the sake of demonstration this state was afterward produced in a number of cases, and it was found that it would most readily happen when the metal was brought quickly to its heat and kept there for only a short time. Under these conditions the temperature of the outside metal would increase much more rapidly than the inside, and when the latter was only at a brazing glow the former would be at a burning heat. The removal from the fire would check the destructive action before it had penetrated to the inside or given any indication to the coppersmith that it had occurred. From this it would appear that burning will generally result when an attempt to hurry the work is made.

A charcoal or coke fire under blast, unless, as is not generally the case in a coppersmith's forge, it is heavy, is not only unsteady from the fact that the fuel consumes rapidly, but is also of irregular intensity at different portions, and occasionally intense heat will occur at a single point. Under these conditions, even if raised to a heat slowly, the metal may be burned.

With a steady heat, and one that could be nicely adjusted, such as would be furnished by a gas flame, which would also permit of both sides of the pipe being directly heated, much better results would probably be obtained.

The burning of the metal accounts for the weakness of the pipe in the vicinity of the brazed joint; but that the failure generally occurs at the edge of the overlap is due to the nature of the strain at this point. The departure of the pipe from a true cylindrical form, by reason of the increased thickness at the joint, causes the strains at each end of the joint to act in parallel, but not coincident, lines, thus producing a couple.

The strain produced by the couple acts equally at the edge of the overlap and underlap, but as the strain on the outside of the pipe is naturally greater than on the inside the point of maximum strain is at the edge of the overlap. Another cause which in a planished pipe tends to somewhat weaken it at the edges of the laps is the slight shoulder which is formed by hammering down the edge of the lap. The shoulder is always more pronounced on the outside, as there is where the hammering is done. Thus, as the point of least resistance and of greatest strain are coincident, it is not surprising that the pipes give way at a pressure considerably below their calculated strength.

In the following table a comparison can be made of the actual bursting pressure and the theoretical bursting pressure of the pipes as calculated by using the figures obtained in the tests for the strength of copper sheet with a brazed joint at 350° F.

Pipes 1 and 2 are considered as having been annealed. The maximum thickness at joint is that at the point of rupture:

Pipe number.	Bursting pressure, lbs. per sq. in. Actual.	Theoretical.	Difference.	Thickness at joint. Maximum.	Relative.
1	835	1,336	501	.362	1.5
2	785	1,336	551	.383	1.6
3	950	1,569	519	.306	1.3
3¹	950	1,469	519	.344	1.2
4	1,225	1,568	343	.301	1.2
4¹	1,275	1,568	293	.325	1.4

That in every case the actual falls below the theoretical bursting pressure by a considerable amount is principally due to the fact that the pipe selects the point of weakest rather than of average strength at which to give way. By taking pipes No. 3 or 3¹, for instance, in which there were no irregular strains, the tensile strength shown by the metal in the pipe was about 16,000 lbs. per sq. in., which is much less than that shown by the weakest specimen. The only practical difference in the conditions of test of the metal in the pipes and in the specimens is that in one case it is in cylindrical form, and in the other it is straight; and it is to this that most of the difference in results must be attributed. In the test of a specimen the strain is evenly distributed, and each fiber or granule sustain its share of the strain; but in the pipe the outer fibers, which, as we have already seen, are the weakest and least ductile, are called upon to sustain the greatest strain. When their limit is reached they let go, and the strain is transferred inwardly to the contiguous fibers, which, being stronger, are able to withstand the increased burden, until by increase of the pressure they too are overweighted. Thus there is a gradual letting go until the pipe is ruptured. The discolorations in the fractures are evidence of this action.

While a thin joint is desirable to decrease the moment of the couple, it is probable, judging from the rupture in pipe 4, that a joint with a thickness relative to the plate less than 1.2 or 1.3 would develop a point of weakness through the laps. It was also determined by the tests of several specimens with brazed joints, in which the laps are of different lengths, that their strength increases with the length of lap, which follows naturally from the action of the couple. On the other hand, the difficulty of making a good joint increases rapidly with the length of the lap. These considerations lead to the conclusion that for pipes of the diameter and thickness of those tested, the best dimensions for the joint are a maximum thickness of from 1.2 to 1.3, and a length of the lap from four to five times the thickness of the sheet.

It is evident that to attain the best results the nature of the metal should be the same throughout the length of the pipe; and this condition can be obtained by annealing or planishing it after the other work has been done, or, as is sometimes the practice, to avoid the danger of changing the form or length of a pipe after it has been made to a template, it is planished to within a few inches of the end before the flanges are put on, and finished afterward. Of the two processes it is plain that planishing is preferable. The loss of ductility which results from the treatment is more than offset by the gain in strength of the sheet; but it is at the joint that the principal advantage is obtained. While the difference in strength between the annealed and planished specimens without joints is from 4 to 5, in the case of specimens with joints it is from 9.5 to 11%. The greater difference is accounted for by the increased resistance to bending which the specimen opposes to the action of the couple. In planishing a joint, however, unless the work is done properly, it may lose rather than gain strength by the operation. The planishing should be commenced at the back of the lap and carried forward to the edge; for if it is commenced at the edge, the lap at this part having become stiffened will separate from the brazing metal and curl up as the work progresses backward.

As neither the banded nor unbanded pipe was distended in the harder metal between the ends it could not be determined whether the bands were sufficiently close together to materially re-inforce the intermediate metal when hard. It is probable that even in the case of a planished pipe, the supporting influence of a band would not be important beyond 2 or 3 ins. from where it was placed.

Of all the specimens tested, the weakest at atmospheric temperature had a tensile strength of 21,021 lbs. per sq. in. Reducing this by 17.7% would make its strength, at 350° F., 19,032 lbs. per sq. in. Using this figure as the strength of metal in a pipe, the bursting pressure would be 1,142 lbs. Still further reducing this result by the greatest difference between the theoretical and actual bursting pressures obtained in the tests, 551 lbs., which is manifestly a large allowance, as only a part of this difference is attributable to the cylindrical form, we have remaining as the pressure at which the pipe will give way, 591 lbs., which is about four times the steam pressure that the pipe will be called upon to withstand.

It would appear, therefore, that unless the workmanship is extremely bad, in which case it would be detected by inspection, there is little chance of a pipe failing under the normal condition of service. The failures that do occur must, except in rare cases, be attributed to careless inspection or the presence of a water hammer, against the action of which no pipe is safe.

A flange joint that was tried on one of the sections of pipe 3 and on pipe 4, was tight up to 600 lbs. per sq. in., when the springing of the joint by pressure on the heads was sufficient to allow it to leak. The joint involves less labor and skill in its manufacture than a brazed and riveted flange joint, and obviates the danger of burning to which the pipe is exposed in brazing on the flanges. It also possesses the advantage of having no rivets, the presence of which is always attended with more or less leakage. An objection to the joint, which, although it did not develop itself during the tests, would probably do so in service, is the hardening of the metal at the turn of the flange, which might occur from the working of the pipe, due to expansion or contraction, and the working of the ship, and which in time would probably result in a crack at this point.

Apropos to riveting the flanges, it was found that the best method was to braze on the flanges first, and then drill the holes and drive the rivets; as, if the rivets are put in first, the heat to which they are subjected in the brazing, wastes and strains them so that, although they may be hammered up afterward, some of them will leak.

The sweated flanges on pipes 3 and 4, appeared to be equally efficient with the brazed flanges; and as the solder melts at 590°, while the melting point of brazing metal is about twice as high, the pipe is exposed to less danger of overheating in putting them on. They also permit of the use of a lighter flange from the fact that a stronger bronze, containing more zinc and less copper, can be used without the danger of its being injured in the brazing. It is possible, however, that the sweated joint would be more easily started by a shock or jar than would the brazed joint, although neither of the sweated joints tried was started by the shock of the pipe explosion.

THE HIGH SERVICE WATER-WORKS SYSTEM OF NEW LONDON, CONN.*

By Walter H. Richards, Engineer.

The city of New London is supplied with water by gravity from a large storage reservoir situated six miles from the city. Until 1889 the supply main consisted of 24-in. pipe for a distance of about 6,000 ft. from the reservoir, where it was reduced to 16-in., continuing of that size to the city. At that time, with an estimated average daily draft of 1,250,000 gallons, the

* A paper read before the New England Water-Works Association, Dec. 14, 1892. Mr. Richards is engineer of the water and sewer department of New London.

pressure in the higher portions of the city, 100 to 120 ft. above mean tide, was so seriously reduced as to deprive some houses of water during a portion of the day, and the 16-in. main was paralleled with a 20-in. But as the higher portion above referred to would still have a pressure of only 30 lbs., or less, it was decided to cut it off from the lower portion of the city, and increase this pressure to about 50 lbs.

The high service district was occupied almost exclusively by residences, and, as the quantity consumed was consequently small the cost of maintenance of a steam pumping plant would have been out of proportion to the results obtained. For this reason a tank was built at an elevation sufficient to furnish the desired pressure, and the tank supplied by pumping from the supply main, the pump being driven by a hydraulic engine, actuated by the water consumed in the lower part of the city. If, for any reason, the tank is shut off from the high service, a check valve between the high and low services furnishes a temporary supply under low pressure.

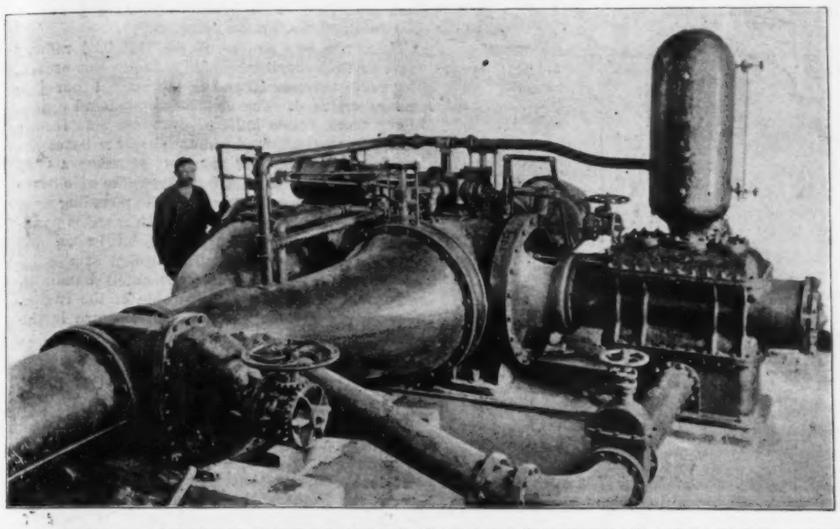


FIG. I. VIEW OF HYDRAULIC PUMPING ENGINE AT THE WATER-WORKS OF NEW LONDON, CONN. W. H. Lang, Burlington, Vt., Engineer; W. H. Richards, Engineer of Water and Sewer Department.

As by the system adopted the pumping is continuous and approximately in proportion to the draft, the tank was small, holding but 90,000 gallons, being designed to furnish water for such small fires as are likely to occur in a residence district, and to supply any temporary disproportion between the draft in the two districts.

A tank elevated on a tower was adopted in preference to the ordinary stand-pipe, because water in the lower portion of a stand-pipe being below the level of the reservoir, would be useless, and would lie stagnant.

The tower rests upon four heavy granite masonry piers laid up in cement mortar. These piers are 10 ft. square at the base, and 6 ft. square at the top, surmounted by pillar blocks of cut stone, 4 ft. square and 10 ins. thick. The piers are 10 ft. deep, and rest on a clayey hardpan formation. Two 1½-in. bolts run from the bottom to the top stone, and the iron bed plates are secured to the pillar blocks by four 1-in. bolts running through this stone, the whole structure being thus fastened together.

The tower consists of four wrought iron lattice posts resting on wrought iron bed plates which support nine plate girders, 4 ft. in depth. The posts are 36 ft. c. to c. at the bottom, and 20 ft. c. to c. at the top, and are fastened with suitable tie rods and braces. The tower is surmounted by a wrought iron tank 25 ft. in diameter and 26 ft. high, built up of plates of the following thicknesses: Bottom ⅛; first plate, ⅜; second plate, 5-16, and third, fourth, and fifth plates, ¼-in. The vertical seams are double riveted, and the bottom and horizontal seams single riveted, with ¾ and ⅝-in. rivets. A 4×4-in. angle iron is riveted at the bottom, and a 4×3-in. T iron near the top. Oak plank hewed to fit the laps are placed between the tank and the girders. All the iron used in the structure is of 45,000 lbs. tensile strength. A suitable iron ladder runs from the ground to the top of the tank, and the tank is provided with a manhole near the bottom. The 10-in. supply and 6-in. overflow pipes are of spiral welded steel. These pipes extend up through the bottom of the tank—the supply pipe to within 4 ft., and the overflow to within 1½ ft. of the top of the tank. Where these pipes are fastened to the tank corrugated copper expansion joints are inserted. The water enters the tank near the top, and by means of a check valve is drawn from near the bottom. The overflow from the tank returns to the low service supply main. All the iron work is thoroughly painted. The capacity of the tank is 90,100 gallons. The height of the tower is 68½ ft., making the entire height of the structure 94½ ft. above the pillar blocks, or 214½ ft. above mean high tide. The tower and tank were built by the Berlin Iron Bridge Co., of East Berlin, Conn.

The engine or motor by which the tank is supplied is in general design an adaptation of the one used at Burlington, Vt., and described before this Association by F. H. Parker,* but is much larger; the motor at Burlington being on a 10-in. main.

The motor is situated on the line of the 20-in. supply main, A, and about 500 ft. from the tower. It consists of a cast iron cylinder 36 ins. in diameter and 8 ft. long, set at right angles to the line of the main, containing a hollow, air-tight, steel plunger, B, 24-ins. in diameter and 54-ins. long, which makes a 36-in. stroke.

On each side of the cylinder are two 24-in. butterfly valves, C, which are connected by means of reducing Ys and 20-in. bends with upright 20-in. Y branches (not shown) set in the low service supply main. The pump is situated at the end of the main cylinder, the pump plunger, E, being on the same rod as the motor plunger. The stems, F, of the butterfly valves run up through the casing and are connected by means of arms and rods with a wrist plate, G, on the center of the motor cylinder.

On top of the main cylinder is an auxiliary cylinder, H, 6 ins. in diameter, taking water through a cylindrical slide valve, I, moved by a tappet rod, K. On the piston rod of the auxiliary cylinder is a piston working in an air cylinder, J, 10 ins. in diameter, which acts as a cushion for the valves. This piston rod is connected with the wrist plate above mentioned. The auxiliary cylinder is actuated by water passing from the low service main and exhausting into the air, or may, when the tank is full, take water from the high service pipe and exhaust into the low service mains. In the first instance the amount of water wasted is 1.1 gallons per stroke; in the latter case no water is wasted.

The supply main runs under the motor, making a by-pass. In the by-pass is a 20-in. check valve which closes by means of a lever, which is weighted so as to offer a resistance of about 5 lbs. per sq. in.

In case of accident to the motor, or if for any reason it should stop at the end of a stroke, the check valve opens and the supply to the city is not interrupted.

The pump is of the usual horizontal plunger pattern. The pump plunger makes the same stroke as the motor plunger, and is 10 ins. in diameter.

The action of the motor is as follows: The water passing to the low service district is deflected by means of the check valve into the motor, passing through one of the butterfly valves, one on each side being open. The water drives the motor plunger over, which, when near the end of the stroke, moves a tappet, K, which latter reverses the valve on the auxiliary cylinder. The action of the auxiliary piston reverses the butterfly valves, opening two and shutting two, by this means deflecting the water to the other side of the motor plunger, which reverses the above operation; the water, after driving the plunger over, passing on to be used in the low service district.

* "Journal New England Water-Works Association," September, 1887; Engineering News, Oct. 1, 1887.

The motor was built by W. H. Lang, Goodhue & Co., of Burlington, Vt.

The machine is experimental and there are many features which might be improved.

It will be seen that all the water used on the low service is drawn through the motor, a portion of its head or pressure being used to drive the same, and the speed of the motor is thus controlled by this draft. For this reason it was necessary to proportion the motor in the ratio of the draft on the low service to the draft on the high service. This was accomplished approximately, although in three miles of cement lined pipe on the high service the leakage is rather larger than expected. On Sundays the draft on the high service is larger than on other days, and as no water is used for manufacturing on the low service on that day, and the speed consequently reduced, the tank is sometimes drawn upon to the extent of about 15,000 gallons.

The speed of the motor varies from 4 to 16 strokes per minute, being about 8 in the night time and 13 in the day time. At about 16 strokes the limit of 5 lbs. loss is reached and the check valve opens. The loss of head in the passage through the motor varies from 2½ to 4 lbs. The head pumped against varies from 18 to 20 lbs.

It will be observed that for an instant during each stroke, while the valves are changing, a passage is open entirely through the motor; but for this it would be a perfect meter. From observation this loss is estimated at 5%, and the consumption on the low service is calculated on this basis.

The present consumption on the high service ranges from 13 to 15% of the amount used in the low service and the capacity of the pump is a little over 15%. The water ram due to the stoppage at the end of each stroke is very slight, rarely amounting to 5 lbs.

Experiments to determine the efficiency of the machine were rather unsatisfactory because of the difficulty of determining the exact pressure at any one time, and because of the continual fluctuation in pressure both on the high and low service; but its efficiency at the usual speed is about 80%, and is higher when running at slow speed.

The machine has now been in satisfactory operation over two years, working day and night, consuming no fuel, and requiring attendance but a few minutes every other day. Its economy has been fully demonstrated, and where the conditions under which it works are similar it might be adopted to advantage in other places.

PATENTS ON ALUMINUM PRODUCING PROCESSES.

The litigation over the process of producing aluminum by means of electrolysis, which has been in progress for some time between the Pittsburg Reduction Co. and the Cowles Electric Smelting & Aluminum Co., Lockport, N. Y., was decided in favor of the former company on Jan. 11, by Judges Ricks and Taft in the United States Circuit Court of the Northern District of Ohio. The history of patents on aluminum producing processes was given very fully in our issue of March 7, 1891, p. 223, but a brief review of the facts involved in the present litigation and of the invention which has now been sustained in the courts may be of interest.

The commercial importance of a cheap method of aluminum production has long been recognized by chemists everywhere. While a student in the scientific course of Oberlin College, Mr. Charles M. Hall became interested in the problem of aluminum production and conceived the scheme for its solution which he afterward carried to practical success. After his graduation in 1884, Mr. Hall endeavored to make the experiments necessary to complete his invention, but, like most young graduates, he was hampered by lack of means to do this. He was engaged for a time with the Cowles Bros., at Lockport, and endeavored to interest them in his process, but was unsuccessful. Mr. R. C. Cole, who was also with the Cowles Bros., became interested in the process, and agreed to aid Mr. Hall in developing it. The two young men went to Pittsburg, where they found able friends and organized the Pittsburg Reduction Co., which at once began manufacuring aluminum by the Hall process. Hall's patent application was dated July 9, 1886, and he claimed in it the method of producing aluminum by electrolyzing alumina dissolved in a fused bath consisting of a fluoride of aluminum, with a fluoride of any metal more electro-positive than aluminum. Mr. Pierre Heroult, of France, applied for an American patent at about the same time on a similar method; and the two applications were put in interference, with the result that the Hall patent was granted, the evidence showing him to be the prior inventor.

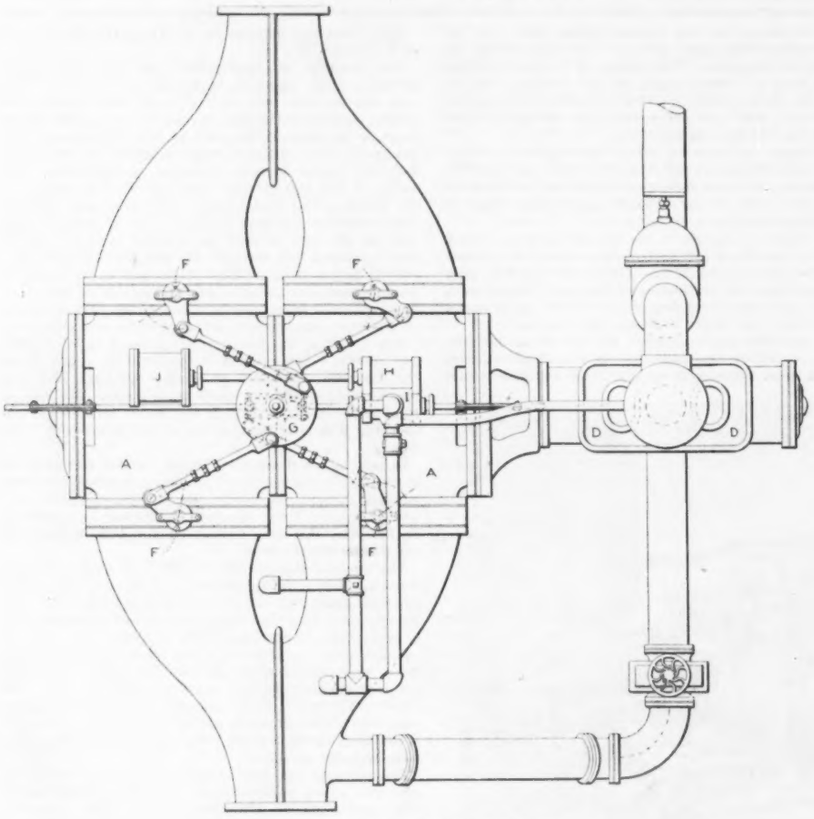


FIG. 2. PLAN OF HYDRAULIC ENGINE.

The Cowles Bros., of Lockport, N. Y., had been for some time engaged in producing aluminum alloyed with copper and iron; but after the marked success of the Pittsburg Reduction Co. in manufacturing pure aluminum, they entered the market as competitors, claiming, we believe, to produce the pure metal, not by electrolysis, but by reducing it with carbon in a furnace heated by electricity, and that the process did not infringe the Hall patent. The Cowles works were situated on an island in the midst of a turbulent stream. Their workmen were sworn to secrecy, and it was with great difficulty that the Pittsburg Reduction Co. finally secured evidence of the infringment of its patent, and in February, 1890, brought suit against the Cowles Co. The suit was stubbornly fought on both sides. The experts who testified for the Pittsburg Reduction Co. were Prof. Chas. H. Chandler, of Columbia College; Prof. John W. Langley, of the Case School of Applied Science, and Dr. Rossiter W. Raymond. Messrs. Geo. H. Christy and Thomas Bakewell, of Pittsburg, were its attorneys. Dr. Wm. H. Wahl, Secretary of the Franklin Institute, was the principal expert for the Cowles Co.

The decision just rendered affirms the validity of Hall's patent, and assures to the Pittsburg Reduction Co. a practical monopoly of the production of aluminum by electrolysis, which is the only method now in commercial use for producing pure aluminum.

The revolution which the Hall process has effected in aluminum production, and the host of collateral industries to which it has given rise, entitles it to rank as one of the great inventions of the century. Its real importance is hardly yet realized. When Mr. Hall began work on his invention, aluminum was little more than a scientific curiosity, and was sold at $8 to $12.50 per lb. The process invented by him has reduced the price as low as 50 cts. per lb., a price at which bulk for bulk it is hardly more expensive than copper, the specific gravity of the two metals comparing as 1 to 3.6. But the actual cost of producing aluminum by the Hall process, when carried on on a large scale, under the most favorable conditions, can be reduced to from 17 to 20 cts. per lb., as shown in detail in our issue of March 7, 1891. Even at present prices, aluminum has found a vast number of important uses in the arts. It will surely find many more. It may well become before long as important a metal as copper, and have no small effect in keeping with the price of copper.

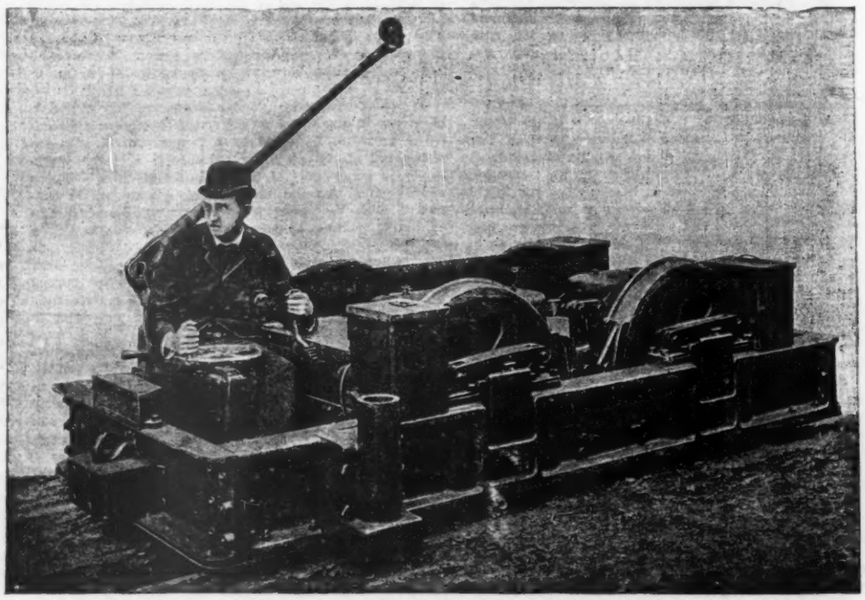
Up to the close of 1889, the total world's production of aluminum had amounted to only 116 net tons, according to the census bulletin reviewed in our issue of July 11, 1891. At present the production must be over 500 tons per annum. It was estimated at 472 tons in our issue of July 28, 1892.

Although production of the pure metal is at present a monopoly in the hands of a single company, the desire to increase profits by stimulating consumption will probably lead to further reductions in the price, notwithstanding the absence of competition.

ELECTRIC LOCOMOTIVE FOR MINES.

The application of electricity for lighting and power in mines appears to be on the increase, owing to the successful results which have been obtained in actual service. In our issue of Jan. 12 we described and illustrated an electric pump in use in a coal mine, and the electric locomotive illustrated herewith has been designed by the General Electric Co. for general mining work. For a track of 30 in. gage the machine is 9 ft. 6 ins. long, 3 ft. wide and about 4 ft. high, extreme dimensions. The wheels are 2 ft. 4 ins. diameter, with 3 ft. 4 ins. wheel base, and the speed is from six to ten miles per hour. The machines are built of varying sizes and capacities, with effective tractive power of 750 to 4,500 lbs. at the drawbar.

There are two motors of the standard railway type, so that coupling or side rods are not needed. For gages between 36 and 18 ins. special four-pole motors are used. The motors are mounted upon a heavy truck frame built of cast iron side frames bolted to steel channel irons. The axle boxes are readily accessible for repairs or renewals of brasses, and the frame is hung from the axle boxes by steel springs, so as to reduce the pounding upon the track. The engine is fitted with a series parallel controller, a powerful toggle-joint brake, and sand boxes at each end. The trolley arm is insulated so that the operator can safely handle it, and it can be placed on either side of the engine, the empty socket on one side being shown in the cut.



ELECTRIC MINING LOCOMOTIVE.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.
XXXVIII.

Comparing the diagrams (published last week) horizontally it will be seen that the central and most darkly colored division, "Collateral Adjuncts" (languages, English studies, etc.), which divides the diagrams into two unequal parts, is itself of very unequal area. Roughly speaking, though with some notable exceptions, the stronger schools tend to curtail this class of studies and the weaker to extend it. The reason is easily seen. It is less expensive work, and requires a less expensive plant and staff to teach this class of studies well, especially when a comparatively weak scientific school is an adjunct of a comparatively strong university, as happens in a number of cases. Moreover, the students come to the weaker colleges, as

a rule, not so well prepared, and have greater need of further general training.

On the other hand, the strong schools tend more and more to high standards for admission, with the effect of throwing back a good part of these studies into the preparatory work, by attracting a larger and larger proportion of students who have had a college or academic training before entering the scientific school. Mr. Seth Low, President of Columbia College, has recently expressed the opinion that it is the plain tendency of all our professional schools to exact such training in effect as a condition for successful following of their course, and that before many years the better class of them will begin to do this formally. These diagrams bear witness to the strength of this tendency. Many strong schools, like the University of Michigan, Columbia, Massachusetts Institute of Technology, Cornell and Worcester Polytechnic Institute (to go no further) have cut down this division of studies to small dimensions. The tendency is not to give more than half a year (20 weeks) to it. Those who give a year or more are, for the most part, the weaker schools.

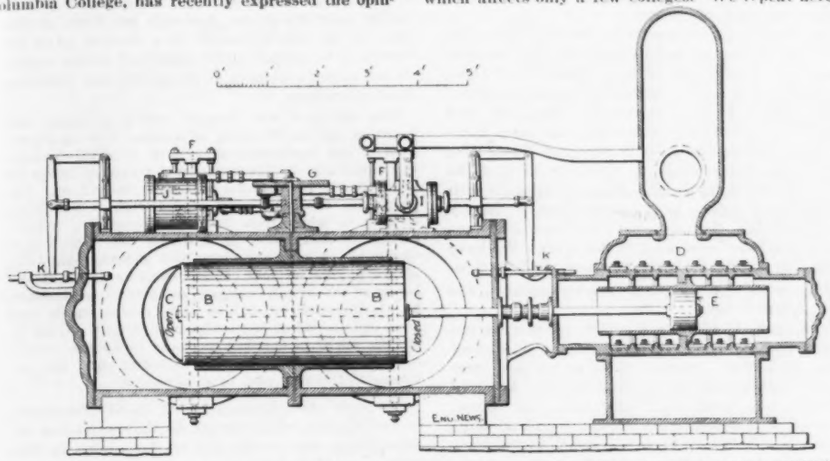


FIG. 4. LONGITUDINAL SECTION THROUGH HYDRAULIC ENGINE; NEW LONDON HIGH SERVICE WATER-WORKS.

The relative size of the two lower divisions of the diagrams (elementary mathematics and advanced mathematics and physics), when taken in connection with the absolute size of each, indicates, with a good deal of accuracy, the comparative stringency of the conditions for admission. The general average of time for these studies may be said to be a year (40 weeks), but a few of the stronger schools have cut this down materially, and mining schools (Nos. 43, 49 and 50) naturally tend to do so.

The all but universal tendency among the stronger schools is to make these three lower classes together occupy what time there is left of the total course after reserving two full years (of 40 weeks each) for the more specialized professional studies which occupy the three upper subdivisions. The apparent irregularity in the total height of the three lower sub-divisions is largely only the effect of the variations in real length of the nominal four-year courses. What time is lost by cutting short the year is largely taken out of these lower studies.

In eight instances the "higher mathematics" sub-division (second from the bottom) will be found sub-divided by a dotted line to indicate an "electricity" or "electro-physics" sub-division. These include all the colleges which, at the time the reports were made out (over a year ago), reported so much as 20% of the total time devoted to mathematics or physics as devoted to electro-physics, as may be seen by referring back to Table XXXIII. (Dec. 1, 1892,). In all these cases, but particularly in the case of Cornell University, No. 30, a good part of this time is devoted doubtless to experimental work of a nature to belong to the upper subdivisions rather than to the lower ones. But the whole question of instruction in electricity is in such a transition state that it is not possible at this moment to give any figures in regard to it that have permanent comparative value. The eight colleges referred to moved a little quicker in this direction than the others, that is all.

It is a somewhat invidious task to comment upon the diagrams of the individual colleges. We prefer to leave them, for the most part, to speak for themselves, with the general remark that there can be but very few errors remaining in the figures on which diagrams are based, excepting the ambiguity in regard to electricity just noted, and which affects only a few colleges. We repeat here also the notice given last week that any errors still remaining in any diagram can be corrected for the re-publication in book form of these articles, if we are advised of the proper correction within one week after publication of this issue.

A few notes as to the individual diagrams, however, seem to be called for.

The Rensselaer Polytechnic Institute (No. 1) is somewhat conspicuous among the stronger colleges for the amount of time it devotes to elementary mathematics. It has to do this because its requirements for admission are modeled somewhat on West Point and are not high. As this college has a full 40-week year, however, this involves less sacrifice of the instruction given in the higher professional studies than it would with most of its rivals.

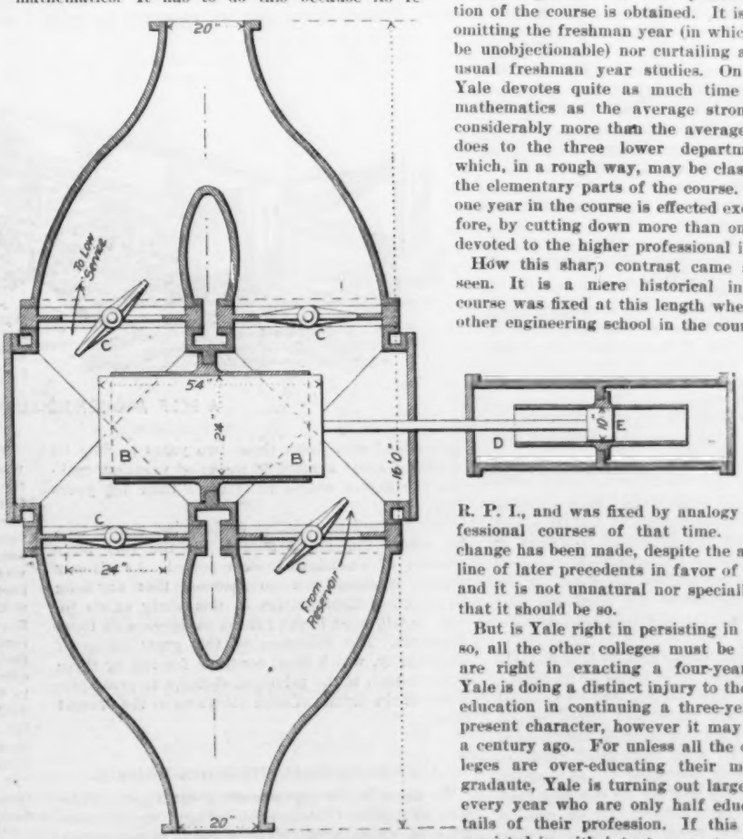


FIG. 3. HORIZONTAL SECTION THROUGH HYDRAULIC ENGINE.

We are informed moreover, that by a change going into effect Feb. 6, the sophomore and junior year has been extended two weeks more, making its full course 164 weeks long. This action, taken by our oldest engineering school after half a century of experience, goes far to convince us that our strictures on the short year of many of our younger engineering schools, published last week, were fully justified. The last four weeks of these two years will be spent in surveying, 10 hours per day for six days in the week.

The Lawrence Scientific School (No. 2) has high requirements for admission, and surrenders remarkably little time to elementary mathematics, but it conspicuously illustrates the tendency already noted, of some of the scientific schools attached to strong universities, to utilize its other and stronger faculties by extending the "collateral adjuncts" of its engineering course at the expense of its strictly professional features. Somewhat of the same tendency is visible in the next diagram of the series, that of the Sheffield Scientific School of Yale (No. 3).

The Yale diagram has a special interest, however, from the fact that Yale is the only one of the stronger colleges which contents itself with a three-year undergraduate course. We do not use the word "strong" in the sense of good, and therefore the University of Virginia and Tufts College, of Massachusetts, which also have only a three-year course, will excuse us for the expression. Moreover, the University of Virginia has three weeks more in its course than Yale, or 117 instead of 114 weeks, and has a six-day instead of a five-day week. We do not attach much importance to the latter fact, as every college can, and beyond doubt does, find out about how much work students can do weekly, month after month, and exact that much, however its nominal class hours may be arranged, but it is a fact to be considered.

The diagram shows exactly how this abbreviation of the course is obtained. It is not gained by omitting the freshman year (in which case it would be unobjectionable) nor curtailing any part of the usual freshman year studies. On the contrary, Yale devotes quite as much time to elementary mathematics as the average strong college, and considerably more than the average strong college does to the three lower departments together, which, in a rough way, may be classed together as the elementary parts of the course. The saving of one year in the course is effected exclusively, therefore, by cutting down more than one-half the time devoted to the higher professional instruction.

How this sharp contrast came about is easily seen. It is a mere historical inheritance. The course was fixed at this length when there was no other engineering school in the country, except the R. P. I., and was fixed by analogy with other professional courses of that time. Since then no change has been made, despite the almost unbroken line of later precedents in favor of a larger course, and it is not unnatural nor specially reprehensible that it should be so.

But is Yale right in persisting in this course? If so, all the other colleges must be wrong. If they are right in exacting a four-year course, then Yale is doing a distinct injury to the cause of sound education in continuing a three-year course of its present character, however it may have been half a century ago. For unless all the other strong colleges are over-educating their men before they gradaute, Yale is turning out large classes of men every year who are only half educated in the details of their profession. If this were done and persisted in with intent, so as to gain thereby the added numbers who might flock to the college to enjoy its royal road to a degree, it would be a

very blameworthy course for such a university. We are confident, however, that has been perpetuated simply because it has been so from the first, without due investigation of the trend of practice elsewhere as shown on the accompanying diagrams. Now that these facts are made clear, however, but two honorable courses are open to the university—either to extend its undergraduate course in engineering to four years, or to raise the standard for admission to its engineering courses up to that now required for entering the sophomore years of the other strong colleges. Otherwise Yale will be doing what she may to degrade the standard of engineering education, which the other colleges, strong or weak, are endeavoring to maintain and to improve, and which is surely none too high at best. That Yale's present undergraduate course is too weak is already recognized in effect, by its requiring two years instead of the usual one year of post-graduate study for the post-graduate degrees.

TABLE XXXIV.—Weeks of Entire Course of the Several Colleges Devoted to the Several Classes of Studies as Below Noted:

	A.	B.	C.	D.	F.	Total.
1. R. P. I.	20	28	30	33	49	160
2. Harvard	8	28	47	34	35	152
3. Yale	12	27	32	30	23	114
5. Union	16	30	44	14	48	152
6. U. Mich.	13	51	23	18	49	144
8. Pa. M. A.	30	20	35	17	38	140
9. Columb.	6	13	15	37	57	128
10. Wash. and L.	31	42	22	26	35	156
11. M. I. T.	10	18	23	21	64	136
12. Lehigh	15	23	32	36	42	148
13. U. Va.	24	20	22	17	34	117
14. Cornell U.	13	21	18	23	85	160
14. Cornell U.	15	24	24	22	75	160
15. Tufts	16	19	9	27	43	114
15. Tufts	20	23	11	21	39	114
16. U. Ga.	32	35	19	34	24	144
17. Lafayette	17	19	39	33	40	148
18. Wash. U.	21	38	23	43	75	200
19. U. Vt.	27	31	28	26	40	152
21. W. P. I.	12	18	22	41	40	133
22. Ala. P. I.	21	20	36	10	65	152
24. Ia. A. C.	17	18	23	15	59	132
25. U. Pa.	13	29	27	32	59	160
26. Stevens	13	25	24	20	78	160
27. U. Wis.	17	29	27	18	57	148
28. Thayer	0	9	1	15	41	66
29. Swarthmore*	33	50	31	17	37	148
30. Cornell M. E.	17	51	5	17	70	160
32. U. Cal.	16	18	32	41	39	146
33. U. Kans.	13	21	27	18	59	138
34. U. Min.	10	14	26	26	72	148
37. C. Coll. Ia.	12	18	37	36	41	144
38. U. Ill.	9	21	24	25	65	144
41. Tex. A. C.	23	11	28	32	62	156
42. U. Neb.	21	38	25	18	40	142
43. Col. S. M.	19	28	21	40	44	152
44. W. U. Pa.	19	31	18	21	59	148
46. Purdue	28	31	20	19	54	152
47. Rose P. I.	17	43	7	19	62	148
Do. (corrected returns)	23	39	29	14	39	144
48. U. Tex.	15	29	40	13	43	140
49. M. M. S.	7	14	24	38	52	135
50. Mich. A. C.	30	39	25	14	36	144
52. Mont. S.M.	8	11	18	54	61	152
Brown Univ.	0	28	34	24	46	152

*These figures are those given in the college, and do not check with Table XXXIII., corrections for which were not sent.

The studies included within each class are given in detail in the headings to Table XXXIII. The classes themselves (also there given) are as follows:

A. Elementary mathematics.

B. Advanced mathematics and physics (including electricity).

C. Collateral adjuncts.

D. Minor technicals—chemistry and surveying, etc. (shown separately on the diagrams).

E. Advanced technicals.

All the courses here given are for civil engineering, except Nos. 26 and 30, which are mechanical, and Nos. 43, 49 and 52, which are mining, all as explained below Table XXXIII.

THIS TABLE IS SHOWN GRAPHICALLY IN THE DIAGRAMS published Jan. 12.

The colleges listed twice above are most correctly represented by the second line, that in which time has been equated to the "class hour" basis.

The Columbia College course (No. 9) is noticeable for its extreme shortness, as an effect of its inordinately long vacations. The result is that its nominal four-year course is but little over three proper years in length. In part, but only in small part, this loss is made up by more than usual vacation work, we believe. The Columbia C. E. course, also, seems to be greatly affected by the fact that it is a later offshoot of a mining course, and is modeled largely on the usual lines of a mining course by giving comparatively little attention to mathematics and much to chemical work.

The Massachusetts Institute of Technology course (No. 11) is also one of those which cuts down its nominal four years to only three and one-third proper years by inordinate additions to the 12-week vacations which even a 40-week course allows. The Worcester Polytechnic Institute (No. 21) shares with it this (in our judgment) unenviable and wrongful peculiarity, otherwise than which these two colleges seem to have pretty near the ideal distribution of time, as we might infer from its results.

The diagrams of Cornell (No. 14) and Tufts (No. 15) will be seen to be divided into two unequal parts by a vertical dotted line. That to the right, the largest and most trustworthy, shows the distribution obtained when laboratory, shop and field "hours" are properly equated with the class hours to represent equal amounts of students' time. The part to the left is made up from the face of the returns as originally furnished us, in which no such equation was made. It is possible, but we hardly think probable, that some of the other diagrams may retain some remainder of this error. We have added the double diagram for these two colleges in order to show about the maximum extent of the error, should it exist.

Washington University (No. 18) appears on the diagrams as the only one exacting a five-years' course (and that a course of 40 weeks per year) before granting any kind of a degree. A letter published last week will show that this course has recently been cut down to one year, and why. Every school in the country, with possible unknown exceptions, has a five-year course for post-graduate degrees, as heretofore stated.

The University of Georgia (No. 16) and of Vermont (No. 19) are notable for the large amount of time devoted to mathematical work, especially elementary mathematics. Most of the younger colleges (Nos. 31 to 52) show something of the same peculiarity.

The Thayer School of Dartmouth College (No. 28) is really a post-graduate school, and hence hardly belongs with the rest at all, but it is not such formally; only an advanced undergraduate school, with the usual freshman and sophomore studies placed among the requirements for admission. Though having only two years left for work, this school cuts down those two years to only 66 weeks of study against 38 weeks of vacation, making the actual course little more than 1½ years long.

The Cornell mechanical engineering course (No. 30; Sibley College) is notable for the very large amount of electrical work reported. As already stated, it should not be assumed that anything like such a disproportion in this study exists today, or will exist in the future, as appears on these diagrams. The existence of this great cause of irregularity, which must continue for two or three years longer, is the principal obstacle to great precision in the details of such diagrams at the present time.

A PATENTED SUSPENSION BRIDGE.

We show in the accompanying cut a perspective view of a patent "suspension bridge," an examination of which is especially apropos in connection with the remarks in another column on the methods of highway bridge construction now in vogue. The construction of the bridge is quite clearly shown in the illustration, which is reproduced from a copy of the patent specifications, and therefore we shall not give a description of the details, which are hardly less novel than the general design, except in so far as to say that the rods, shown fitted with turnbuckles in the illustration, form continuous cables, binding the bridge from end to end, and, so far as we can ascertain, are not fastened to any of the bridge members. The "advantages" of this bridge over others are modestly set forth as follows by the manufacturers in a circular letter intended to be mailed to the judges of county courts in the various counties of Arkansas, and soliciting their patronage:

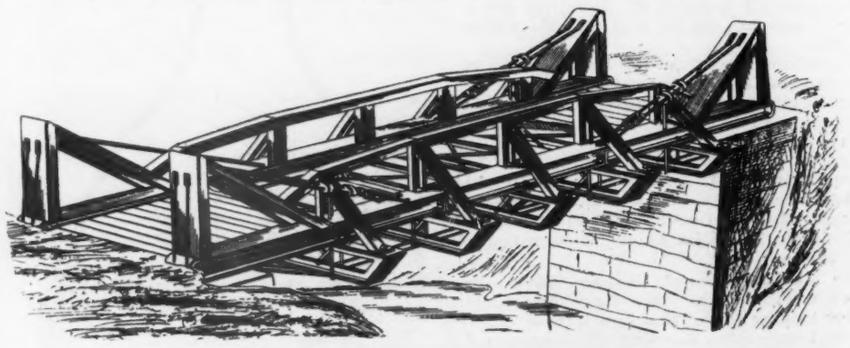
This we deem the cheapest and best bridge ever built. It has the following advantages over all others, viz.: 1. The combination of greater strength, economy and simplicity. 2. The least static weight of bridge for any capacity per foot for sustaining weight, and consequently, the least cost of material. 3. The least liability to injury from floods and tornadoes. 4. Suitability for many sites, at moderate cost, where it is impossible to build any other kind of bridge except at almost prohibitory cost. 5. In lieu of anchorage in the banks of the stream complete and perfect, self-anchorage is obtained by endless steel cables which pass from end to end of the bridge and entirely around it, binding its parts together the more firmly the heavier it is ladened. (We own the exclusive right for Arkansas to this new plan of construction.)

We leave the consideration of these advantages to our readers, only remarking that a method of determining the distribution of the strains in this bridge would undoubtedly exceed in interest the design itself.

EXTENSION OF THE OUTFALL SEWER UNDER THE HARBOR AT NEW LONDON, CONN.*

By Geo. K. Crandall, Assistant Engineer, New London Sewer Department.

In 1886 the city of New London, Conn., commenced the construction of a separate system of sewers. About 1¼ miles of the main intercepting sewers were built in that year, and sewers have been added each succeeding year. As it was designed to have but one outlet for this portion of the city, these sewers were united in one 24-in. pipe, designed to be duplicated hereafter, discharging into the harbor under one of the wharves.



A SELF ANCHORING SUSPENSION BRIDGE.

This was designed as a temporary outlet, although it was thought that it would answer for some years; but the presence of dye wastes emptied into the sewer from one of the silk mills became very objectionable, particularly to the fish markets in the vicinity, and the necessity for carrying the sewage farther away soon became apparent. Consequently a series of experiments was made with floats to determine the currents in and about the wharves, and to ascertain how far out it would be necessary to extend the pipe. Many kinds of floats were used, both for surface and deep water currents, but most of the results were quite unsatisfactory, as the floats were found to take different courses at different times when the conditions appeared to be the same. As regards the forms of the floats used, the most satisfactory results obtained were from the surface floats made of a quart bottle with a long neck and a wire sticking up through the cork with a number on for identification.

It was finally decided that at a distance of 800 ft. from the end of the old outlet there would be no danger of the sewage setting back into the slips.

There was a depth of 18 ft. of water over almost the entire length of the proposed line, and it was in a part

*Slightly condensed and altered from a paper read at the annual convention of the Connecticut Society of Civil Engineers and Surveyors, held at Hartford, Jan. 10, 1893.

of the harbor where there is much anchoring of vessels. There being no sudden slope of the bottom at the so-called channel, as was supposed to exist by some people, and it being advisable to lay the pipe from 4 to 6 ft. under the mud as a protection against anchors, it was necessary to lay it in the form of an inverted syphon.

Three kinds of pipe were given careful consideration, cast iron, spiral welded steel, and wood, and three special requirements were considered, durability, ease in laying, and cost. The question was finally decided in favor of the wood: First on account of its durability, as

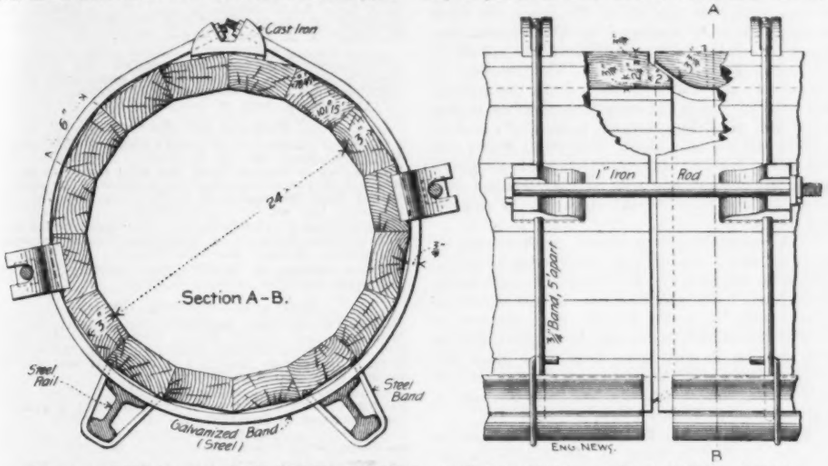


FIG. 1. DETAILS OF SUBMERGED WOODEN OUTLET SEWER, NEW LONDON, CONN.
Mr. W. H. Richards, Engineer, Mr. Geo. K. Crandall, Assistant Engineer.

it is a well known fact that wood entirely submerged will last for an indefinite time, and that the salt water would materially affect cast iron and steel; secondly on account of the ease in laying, as it could be made in much longer sections, requiring fewer joints and would be much easier to get into place than the heavier pipes; and thirdly the cost was found to be from 10 to 15% less than the other materials mentioned. The pipe used was 24 ins. in diameter, and was made of green cypress staves 3 ins. thick, cut on the radius and planed on all sides. It was built on the beach parallel with the shore, in lengths of 175 ft. The staves were not less than 20 ft. in length, put together so as to break joints and were bound together by three ¾-in. steel rods, double galvanized, drawn together on the top in a special saddle made for the purpose. Stop-waters were put in at all butt joints. As the wood weighed a little less than 50 lbs. to the cubic foot it was necessary to weight it, and this was done with old rails fastened to the pipe by means of iron staples. The details of the pipe and fastenings are shown by Fig. 1.

At a point about 100 ft. back of the old outlet and at the end of the tile pipe, a settling basin was built, to catch any heavy matter which might settle in the submerged pipe and clog it, in the following manner:

The filling under the wharf, which consisted almost entirely of stone, was excavated to the proper depth, and a solid stone foundation was laid. Then a wooden caisson 6 ft. 9 ins. square and 8 ft. high was built on the wharf, of 3-in. yellow pine, lined with brick. This was sunk onto the foundation, and a stone wall built all around on the outside. This made a water tight basin which can be pumped out and cleaned at any time by turning the sewage into the old outlet.

After this basin was completed, or nearly so, a trench was dug out into the harbor, varying from 8 to 14 ft. in depth. Most of the trenching was done with a clam-shell dredge, but the leveling off of the bottom and some of the harder portions required the aid of a suction pump and a submarine diver. The bottom of the harbor consisted in most parts of soft, sticky mud, but in some places a gravel and hardpan was found underneath.

After a suitable length of trench was ready a section of pipe was towed to a position directly over it, being held up by barges and then allowed to sink into place, where it was adjusted by a diver.

The joints were of two kinds, one being used where the wooden pipe was fastened to the cast iron bend used under the wharf and consisting of plain cast iron flanges, bolted to the pipe. The others were the joints between the sections of the wooden pipe, and were made by tapering off one end and cutting out the other, making a joint similar to the ordinary joint used on cement pipe, the sections of the pipe being drawn and held together by means of 1-in. iron bolts put through brackets on the sides of the pipe, all as shown in Fig. 1.

As soon as one section of the pipe was in place and found to be on the proper line and grade, the trench was backfilled with the material excavated from the next section ahead, and so on until the last section was laid.

After one of these sections had been laid and some of the backfilling done, it was found that it was being forced up by the mud, which was dumped from a scow, and it was necessary to drive piles along the sides and fasten it down, and this course was pursued with all the remaining sections.

As the bottom of the pipe at the discharge end was about 8 ft. below the surface of the mud, it was necessary to put on a riser. This consisted of a cast iron elbow made especially for it with a flat base, a riser of 24-in. cast iron pipe, and a cast iron bonnet, which was placed on the top as a protection against tons. This is shown by Fig. 2. This outlet was built on a pile foundation and surrounded by cement concrete put down in bags. The top of the pipe where it leaves the settling basin is at the level of mean high tide, and from there it is laid on a grade of 64 to 100 for the first 36 ft., and the remainder of the distance it is on a grade of 1 in 850, with the rise at the end, making the discharge 18.8 ft. below mean high tide.

The work on this extension was done under the direct supervision of the writer, and in accordance with the plans and directions of Mr. W. H. Richards, Chief Engineer. It was commenced in the latter part of

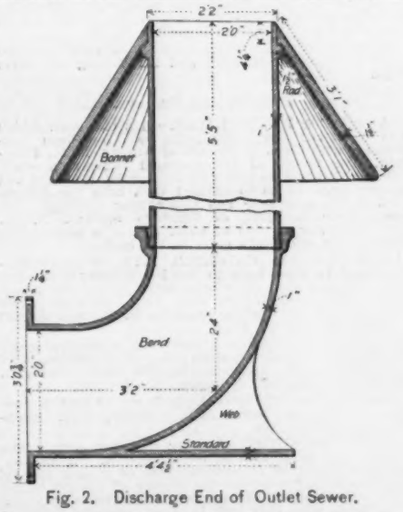


Fig. 2. Discharge End of Outlet Sewer.

July, 1892, and the sewage was turned into the new pipe in November of the same year, since which time it has been working very satisfactorily.

A NEW ARTIFICIAL STONE.

The Medusaline Manufacturing Co., of Chicago, Ill., has been for some time engaged in the development of a new variety of artificial stone, which is claimed to be superior in strength and appearance to the artificial stone generally produced. Tests have shown a crushing strength quite equal to that of the best limestones and sandstones, and the material can be produced of any shade of color desired, and of any form or shape which can be cast in a mold. The fracture is much like natural sandstone, as might be expected, sand being a chief ingredient of the material.

The important question to every engineer in examining any form of artificial stone, however, is, what is its composition; for only by knowledge of that can a satisfactory idea be obtained of its durability. Medusaline may be defined as an artificial sandstone in which the separate grains are cemented together by an oxychloride or oxysulphate of magnesium. This compound has been known to chemists for some time as one of the hardest and toughest of artificial minerals. It crystallizes in its formation and will take an excellent polish, whereas, so far as we now recall, other forms of artificial stone work will not take a polish.

An effectual obstacle to the use of these compounds of magnesia in artificial stone manufacture, however, has been the fact that they rapidly decompose when subjected to the action of carbonic acid gas in a moist atmosphere. The inventor of medusaline, Mr. Louis Enricht, C. E., had his attention called to the remarkable hardness and strength of oxychloride of magnesium some years ago, and began experimenting with a view of finding some method of making the compound durable in the presence of carbonic acid or moisture. The desired effect was at length obtained by treating the compound with aluminum or magnesium palmitate, a salt of palmitic acid, or with an acid, non-coagulable, albumen. This combines so thoroughly with the other ingredients during the formation of the oxychloride that it will withstand perfectly the action of moisture and carbonic acid. For more detailed information concerning the composition of medusaline reference may be made to the patents recently issued to Mr. Enricht (Nos. 486,443 to 486,450 inclusive).

Of course the relative proportion of the ingredients used in the manufacture of artificial stone by this process is varied according to the use to which the material is to be put. A fair sample of the proportions would be:

Magnesium oxide (MgO) by weight	13	parts
Magnesium chloride ($MgCl_2$) by weight	6	"
Aluminum or magnesium palmitate, by w'g't.	0.65	"
Sand, by weight	100	"

If a colored stone is desired, mineral coloring matter, usually an oxide of iron or manganese, is added.

The raw material used by the company is magnesite (magnesium carbonate), a mineral obtained in large quantities from Greece and from mines leased by the company in Cecil County, Maryland. The magnesite is crushed and ground at the company's works and strongly heated, which drives off the carbonic acid and leaves magnesium oxide, MgO. The magnesium chloride is obtained by adding the oxide to hydrochloric acid, and the palmitate of alumina, which is a yellowish powder, is added to the diluted solution of the chloride.

This solution is mixed with the oxide and the sand in about the proportions noted above in a C. Ross & Sons' mixer, with a capacity of four tons per hour.

After being thoroughly tempered the mixture is poured into molds, which have been oiled to prevent its adherence, and allowed to set. If necessary for rapid work, these molds are transferred to a drying kiln, which is maintained at a temperature of from 125° to 135° F. In four hours the medusaline has attained a compressive strength of about 2,500 lbs. per sq. in., and in 10 hours it is ready for use. Under ordinary circumstances, however, it is considered advisable to permit the medusaline to set for several days before using, as it continues to grow harder for weeks and even months after casting, when exposed to ordinary temperatures only.

The name "Medusaline," while frequently applied to the finished product, was originally coined to designate the compound which is mixed with the sandstone and acts as a cementing material. The derivation of the name is obvious, Medusa in Grecian mythology being a lady who had the highly uncomfortable habit of turning into stone whomever she looked at.

Especial interest attaches to the products of the Medusaline Mfg. Co. from the fact that it has gone far beyond the ordinary applications of artificial stone for structural purposes, and while it does make copings, water tables, columns and all sorts of architectural stone work, a great variety of

ornamental work, plumber's ware, etc. is also produced. The material being cast, can be produced with any desired surface from a dead smooth (produced by casting against a surface of glass) to a finish in imitation of rock face, drafted, or hammered masonry. To imitate colored marbles, different colors are mixed separately and then united in the same mold, a net being drawn through the soft mass to produce a blending, which is further perfected by the crystallization that takes place in hardening. For such ornamental work a thin coating of the mixture tempered rather soft is placed first in the mold against the glass and the interior of the mold is then filled with material tempered in the ordinary way. Among the articles produced by the company are grindstones, emery wheels, laundry and bath tubs coated with an enamel claimed to be equal in appearance to that on a porcelain lined tub and much less in cost, billiard table beds, panels, tiles, mantels, etc.

Ordinary medusaline can be furnished on the ground at about 90 cts. per cu. ft., including the ornamentation. Its weight is 120 lbs. per cu. ft.

Tests reported on samples of medusaline by Messrs Lewinson & Just, of 90 Nassau St., New York, in March, 1891, showed an average compressive strength of 10,930 to 12,110 lbs. per sq. in. The tests were made by Fairbanks & Co. on 1-in. cubes six days old pressed between pine cushions. Briquettes of the standard form, subjected to tensile test, showed 850 to 886 lbs. per sq. in. ultimate strength.

Tests to determine the effect of frost on the material were made by Rattle, Nye & Hollis, of Chicago, in August last. The samples were immersed in a sulphate of soda solution for 48 hours and showed practically no loss by scaling.

Among present contracts on hand by the Medusaline Co. are stone work in imitation of Bedford limestone for the factory of the Warner Safe & Lock Co., at Hempstead, Ill., and ornamental stone work in Chicago for nine houses at Central Park Boulevard and Twenty-fourth St., three houses at Forty-fifth St. and Woodlawn Ave., house and stable at Fifty-seventh St. and Kimbark Ave., and others.

The substance which has been christened medusaline is the invention of Mr. Louis Enricht, C. E., a graduate of the technical school at Carlsruhe, Germany. A company to develop the invention, under the name of the Enricht Mfg. Co., was first organized in New York city, but seems to have been abandoned for some reason, and was succeeded by the Medusaline Mfg. Co., of Chicago. Its offices are at 318 Chamber of Commerce Building, and its works, which have a daily capacity of 60 tons, are at Grand Crossing, Ill. Mr. D. V. Purington, a well known brick manufacturer, is President, Mr. Louis Enricht is Chemist and Superintendent, and Mr. Fremont Hill, C. E., is the General Manager.

THE IRON ORES OF MINNESOTA.

During the ore-shipping season of 1892 at Duluth, the total shipments of Vermillion Range ore were 1,155,490 gross tons, as compared with 885,520 a year ago, and 62,122 in 1884, when the first season shipments were made. A grand total of 5,175,683 gross tons had been shipped during the nine seasons since the range was first developed. Besides this, the first two cargoes of Soft Mountain iron from the new Mesaba Range aggregated 4,500 tons. Vermillion Range shipments next season, with the new mines, the Pioneer and the Zenith, which are to be actively operated, are said to be likely to reach 2,000,000 tons. The Great Western Iron Co. has sold 40 acres of its property on the Mesaba to Detroit and Cleveland parties for $300,000. Ore to the amount of 800,000 tons is said to have been shown up on nine acres, with the drills down only 24 ft.

The hard ore mines of the Lake Superior districts, while not yet directly threatened, have been made to feel the possible injury to their markets in consequence of the development of soft iron ore mines on the Mesaba Range. Furnace men are said to have been showing a preference for soft ores, owing to the greater convenience in handling and working that product at the furnaces. While, as a rule, the hard hematites are higher in metallic iron than the soft, the furnacemen have been willing to overlook this important fact, in consideration of the advantage in working the soft ores. Hence the Vermillion and Marquette ranges, with their hard ores, are those more particularly called upon to face this matter, and one of the Vermillion companies has taken the first step toward overcoming the difficulty.

The Minnesota Iron Co. has erected a 23-ton ore crusher, the first ever built to crush ores in competition with soft hematites. Its jaws are large enough to take in blocks of ore 20×24 ins., and break them into pieces small enough to permit of convenient and easy smelting. The machine is located near the mouth of No. 8 shaft, the hoisting apparatus of which has been altered so as to permit of the car being elevated fully 15 ft. higher, to dump the ore on a sieve. The small pieces will drop to the crusher near by, after passing through which the crushed ore will be also dumped into tram cars, and taken to the stock pile or railway cars.

If the undertaking is a sucess, crushers will be put in at other shafts, and the system probably eventually adopted by the Marquette companies, which have been watching the developments in Duluth with interest, for if the crusher is found practical and the system is demonstrated to be a success, it will serve largely to place the hard ore mines again in supremacy, as the product is higher in iron, and carries less moisture, and is therefore a more desirable ore.

Less timber is used in hard ore mines than in soft, and in such a mine as the Minnesota immense stopes are broken readily and cheaply. These advantages will tend to offset the extra expense of crushing.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

LAKE ERIE & DETROIT RIVER.—This road was extended in 1892 from Leamington, Ont., to Merlin, Ont., 23 miles, and 13 miles from Merlin to Blenheim, Ont., were graded.

BALTIMORE FORWARDING & R. R. CO.—This company, which is now operating the Baltimore & Lehigh R. R., has let the contract for changing the track to standard gage. Work is to be commenced at once.

CONCORD & MONTREAL.—A bill has been introduced into the New Hampshire legislature authorizing the Manchester & North Weare R. R. to extend its line from North Weare to Henniker, N. H.

OHIO SOUTHERN.—Ten carloads of rails have arrived at Springfield, Ohio, and tracklaying will soon begin at this place.

Projects and Surveys.

SARANAC & LAKE PLACID.—This company, which was chartered about two years ago, has been reorganized, with Chas. E. Arnold, of Albany, N. Y., President. The length of the proposed railway is seven miles, and it will be laid with three rails, standard and narrow gage, so as to connect with both the Adirondack & St. Lawrence and Chateaugay railways. Ch. Engr. Jesse S. Mott, of Saratoga Springs, N. Y., will begin the surveys at once, and it is stated that construction will begin early in the spring.

LACKAWANNA, CATSKILL MTS. & BOSTON.—Chartered in New York to build a railway from Deposit, Broome Co., to Schenectady, N. Y., 130 miles. Among the incorporators are: Benj. Harmon, New York city; G. F. Shaver, Yonkers, N. Y., and Arthur E. Rice, Passaic, N. J.

SOUTH MOUNTAIN.—A corps of engineers under the direction of M. C. McDaniels, with headquarters at Slatington, Pa., are surveying this old line between Harrisburg, Pa., and Newburg, N. Y.

COLUMBUS & BEDFORD.—It is stated that a company will be organized to build a railway from Columbus to Bedford, Ind.

NEW HAMPSHIRE.—A press dispatch says: "The citizens and hotel men of Bethlehem, N. H., are agitating in favor of the construction of a new line of railroad to that point for the benefit of visitors to the White Mountains. One or two public meetings have been held with this end in view. Several different routes have been considered. An idea that meets with much favor is to change the main line of the Concord & Montreal from the circle it now takes around the river via Wing Road, and build a straight line from Littleton, through Bethlehem to Bethlehem Junction."

Southern.—Existing Roads.

OCONEE & WESTERN.—The contract for completing this railway has been let to J. W. Willis and S. Holdshoser, the work to be completed in 90 days. The portion between Grovania and Hawkinsville, 13 miles, is already graded, and only awaits the laying of rails. The uncompleted portion between Dublin and Spring Haven will be graded and finished at once. When completed, the road will extend from Dublin to Grovania, a distance of 63 miles.

ATLANTIC COAST LINE R. R. CO.—This company has been organized to assume control of the affairs of the Macon & Atlantic R. R. Co., and to complete its partly graded line from Macon, Ga., to the Atlantic coast.

LOUISVILLE, ST. LOUIS & TEXAS.—Work is being pushed on the branch from West Point to South Park, Ky., and it is expected to have the grading completed in a few weeks. Tracklaying is to begin at once. Preparations are being made to build a bridge over Salt River.

RALEIGH & WESTERN.—A force of about 2,000 men are now at work on this North Carolina railway, and five miles of the grading have been completed, and a small amount of track laid. The road is to run from Egypt, N. C., via Gulf, Harper's Cross Roads and Enterprise, to Asheboro, N. C., 45 miles. The surveys have been completed, and the contracts for material let. There will be two 150-ft. span bridges. Ch. Engr., J. J. Sickler, Egypt, N. C.

LOUISVILLE TERMINAL.—Three miles of this road at Louisville, Ky., have been graded. Six miles are under construction, and surveys are being made for an additional ten miles. Gen. Man., J. C. Fawcett; Secy., C. C. McClarty; both of Louisville, Ky.

Projects and Surveys.

POINT PLEASANT, BUCKHANNON & TYGART'S VALLEY.—Secy., W. G. S. Fallen, Buckhannon, W. Va., writes us that nothing has been done but call a meeting of the stockholders to organize. The road is to run from Bellington to Buckhannon, W. Va., but the route has not been determined.

BURNSIDE & MONTICELLO.—The construction of a railway from Burnside to Monticello, Ky., is proposed. W. Godfrey Hunter, Burnside, Ky.

LOUP CREEK & PINEY.—This railway company has been chartered in West Virginia.

Northwest.—Existing Roads.

DULUTH & IRON RANGE.—The contract for the branch to the Virginia Mines, Minn., 7½ miles long, has been let to Winston Bros., St. Paul, Minn. The work will be very heavy, and the total cost of the branch is estimated at $250,000.

BURLINGTON & MISSOURI RIVER.—This company has entered into a contract to build a railway from Portland to Spearfish, S. Dak., 28 miles.

DULUTH, MESABI & NORTHERN.—The contract for building the 7-mile extension has been let.

SIOUX FALLS, YANKTON & SOUTHWESTERN.—The surveys have been completed for this line from Sioux Falls to Yankton, S. Dak., and the right of way secured. Construction is now in progress. Ch. Engr., W. H. Knowlton, Sioux Falls, S. Dak.

Southwest.—Existing Roads.

WACO & NORTHWESTERN.—A press dispatch from Waco, Tex., says: "H. R. Green, the purchaser of the Waco & Northwestern R. R., has decided upon several extensions which will greatly benefit that road. He has arranged for a survey of the route from Waco to Garrett, Ellis Co., Tex., for a connection at Garrett with the Texas Midland R. R. Another engineer corps will leave Roberts, Hunting Co., the north terminus of the Midland, and will run a line across Delta and Lamar counties to Paris, Tex., to which point track will be built for a connection with the St. Louis & San Francisco R. R. Construction on these extensions will be pushed as soon as the surveys can be made and right of way obtained. Mr. Green is also having a survey made from Bremond to Beaumont, near the Gulf."

SPRINGFIELD, SEDALIA, MARSHALL & NORTHERN.—Fairly good progress is being made in securing local subscriptions in aid of this road, and the projectors state that construction will begin soon.

GULF COLORADO & SANTA FE.—This company intends extending its Alvin Branch to Velasco, Tex.

Projects and Surveys.

MEMPHIS & JOPLIN.—A company is to be organized to build a railway from Memphis, Tenn., to Joplin, Mo. J. A. Grayson, Joplin, Mo.

TRINITY, CAMERON & WESTERN.—It it stated that arrangements are being made to build this railway from Trinity to Granger, Tex., 113 miles.

LUFKIN, SOUTH & SOUTHEASTERN.—The officers of this company, whose incorporation was noted in our issue of Dec. 29, are; Pres., E. J. Mantooth; Vice-Pres., S. W. Henderson, and Secy. and Treas., B. F. Bonner.

EXCELSIOR SPRINGS.—Chartered in Missouri to build a railway from Excelsior Springs to Cooley's Lake, 12 miles. Among the incorporators are: S. F. Scott, H. R. Robinson and P. Daugherty.

LA FAYETTE.—This is the name of the railway which is to be built from La Fayette, Tex., to Canyon Switch. F. C. Cle, La Fayette, Tex.

Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—Surveys are reported in progress for the proposed branch from Kootnai Station, Idaho, to the International line. It is stated that the branch will be constructed this year.

RIO GRANDE SOUTHERN.—It is stated that the money necessary to build the extension from Mancos or Dolores, Colo., to the San Juan mining fields.

GREAT SALT LAKE & HOT SPRINGS.—It is stated that an extension to Coalville, Utah, will be built this season.

Projects and Surveys.

PORT ANGELES CENTRAL.—Renewed efforts are being made to secure the construction of this railway from Port Angeles south to Gray's Harbor, Wash. Surveys have been made from Port Angeles south about 50 miles. Chas. Gore, Washington City, Wash., is interested.

BRITISH COLUMBIA.—Applications will be made at the coming session of the British Columbia Legislature for authority to construct the following lines of railway: From Golden to the boundary line; Trail Creek Mines to boundary; Nelson to Carpenter Creek; Lardeau City to Nelson; Kootenay Lake to Bear Lake; Okanogan Lake to boundary; Revelstoke to Upper Arrow Lake; Nakusp to Forks Carpenter Creek; Kaslo City to boundary line; Bedlington, Kootenay, to Lardeau. These are all roads to open up the mines.

CREEDE & GUNNINSON SHORT LINE.—Surveys have been commenced for a narrow gage railway from Jimtown, Colo., up the face of the mountain to mines. The line will be about seven miles long and the maximum grade 4°.

ELECTRIC RAILWAYS.

BUFFALO, N. Y.—Chartered, Buffalo & Tonawanda Electric Ry. Co.; Buffalo to North Tonawanda, 4 miles; capital stock, $100,000; incorporators, Wendell Goodwin, New York city; W. P. Whittock, Elizabeth, N. J.; Frank A. Dudley, Niagara Falls, N. Y.

PATERSON, N. J.—Chartered, Grand St. Electric Ry. Co.; capital stock, $35,000; F. C. Van Dyke, J. A. Morrisse, M. Clark.

DARBY, PA.—Surveys are being made for an electrical trolley railway in Delaware Co., Pa., from Darby to Marple, for the Delaware County Electric Ry. Co. This road is expected to be completed early in spring. Enos M. Harris, Jr., C. E., of Darby, is engineer, and Chas. Fischer is assistant in charge of surveys.

READING, PA.—The bill granting the City Passenger Ry. Co. to use the trolley system has been passed by the Common Councils. The company operates about 23 miles of road.

LACONING, MD.—The Laconing & Cumberland Electric Ry. Co. has been organized to build an electric railway from Cumberland to Westernport, Md.; 30 miles. John J. Bell and Geo. W. Clark.

COLUMBUS, O.—The Columbus & Harrisburg Electric St. Ry. Co. has been chartered at Columbus, O.

MONTGOMERY, ALA.—The Montgomery Terminal & Electric Street Ry. Co. has decided to equip its railway with electric power. The board of directors estimate the cost at $125,000, and intend to have work commenced within sixty days. The road is now 10½ miles long and is to be extended.

VICKSBURG, MISS.—Chartered, Vicksburg Electric Transit & Light Co., Vicksburg; to operate railway, and supply electric light to Vicksburg.

WEBB CITY, MO.—Chartered, Carterville & Webb City Electric Ry. Co.; Carterville to Webb City, Mo., 10 miles; C. A. Parker, L. P. Mann, A. G. Carter.

HOT SPRINGS, ARK.—The Hot Springs Ry., 4 miles long, will adopt electric power. S. W. Fordyce, St. Louis, Mo.

ELEVATED RAILWAY.

PHILADELPHIA, PA.—The Philadelphia Elevated R. R. Co., has been chartered to build an elevated railway in the city of Philadelphia, Pa. The route of the road will begin at Independence Square, at 6th and Sansom Sts., and run up Sansom to 22d St., thence south to Walnut St. and west on Walnut St. to 40th St., and to Baltimore Ave., and from there to a point in Delaware Co. at or near the intersection of Cobb's Creek and Baltimore Ave., a total distance of five miles. Pres., Wm. H. O'Brien.

HORSE AND MOTOR RAILWAYS.

BRIGANTINE BEACH, N. J.—Chartered, Brigantine Transit Co.; capital stock, $250,000; J. Thompson, Atlantic City, N. J.; G. H. Cooke, New York, N. Y.

ORANGE, N. J.—Chartered, Orange Valley St. Ry. Co.; capital stock, $100,000; incorporators, J. S. Holmes, S. D. Day, G. Spottiswoode.

GETTYSBURG, PA.—Chartered, Granite Hill R. R. Co.; capital stock, $10,000; Pres., David Wills, Gettysburg, Pa.

LANCASTER, PA.—Chartered, Lancaster & Manheim Ry. Co.; Lancaster to Manheim; capital stock, $50,000; Pres., John A. Coyle.

OAK RIDGE, PA.—Chartered, Mahoning & Allegheny R. R. Co.; capital stock, $110,000; Pres., J. C. Baker, Oak Ridge.

EVERETT, WASH.—Chartered, Everett & Snohomish St. Ry. Co.; capital stock, $100,000.

HIGHWAYS.

NEW YORK.—The Commissioners of Highway Improvement of New Rochelle have organized with the following officers: Chn., Henry L. Nelson; Treas., Col. DeLancey A .Kane; Secy., Henry D. Phelps. This Commission is to superintend the macadamizing and rebuilding of the roads, for which the village recently voted to raise $50,000.

CALIFORNIA.—The Alameda Improvement Assn. is agitating the building of a road from Alameda to San Leandro. Several routes are under consideration.

WASHINGTON.—The Commissioners of King Co., at Seattle, have awarded to T. F. Townsley the contract for a wagon road in the eastern part of the county, 18½ miles long, to the Cedar Lake mines.

BRIDGES, TUNNELS AND CANALS.

ROCHESTER, N. Y.—The following bids were received for constructing the stone arch bridge at Court St.; J. Y. McClintock, Cy. Sur.:

Chambers & Casey	$148,549
Whitmore, Rauber & Vicinus	153,428
Laurr, Haguman, Albaugh & Co	137,931
Ellsworth & Grant	140,024
Robinson & Pond	159,599
B. P. Smith	151,855

Bids were also received on the same date for the stone arch bridge at Andrews St.:

Chambers & Casey	$73,873
Ellsworth & Grant	72,537
Whitmore, Rauber & Vicinus	72,945
B. P. Smith	73,420

MADISON, ILL.—The St. Louis Merchants' Bridge Co. has been chartered in Illinois with a capital stock of $350,000.

TUNNELS.—The West Chester & Long Island Tunnel Co. has been chartered in New York to build a tunnel from the town of West Chester, N. Y., under Long Island Sound to College Point, N. Y. The tunnel is to carry a railway to be operated by steam, electricity or other power. Incorporators: Chas. M. Reynolds, New York city; Geo. A. Hammill, Jersey City, N. J.

WATER-WORKS.

New England.

PITTSFORD, VT.—The contract for works has been awarded to Flood & Sherrill, Sandy Hill, N. Y. There were eight bidders, their tenders ranging from about $21,000 to $30,000.

BOSTON, MASS.—Bids will be received until Jan. 25 for 10 tons, 4-in., 600 tons, 6-in., 400 tons, 8-in., 100 tons, 16-in., 390 tons, 24-in., and 1,100 tons, 36-in. cast iron pipe; also for 100 tons specials. Address Water Board.

WORCESTER, MASS.—The contract for pipe for the ensuing year has been awarded to R. D. Wood & Co. for $21.48 per ton; the same firm has the contract for specials at 2.4 cts. per lb. A contract for small iron castings has been given to the Holyoke Machine Co., Worcester, for 2⅝ cts. per lb. Pig lead will be furnished by Webster & Crosby, Worcester, for $3.92 per cwt., and lead pipe for 5 cts. per lb.

BIRMINGHAM, CONN.—It is stated that the company will add 125 meters to the 25 now in use.

GUILFORD, CONN.—There is talk of building works.

Middle.

CASSADAGA, N. Y.—It is reported that action is being taken to secure works.

ROCHESTER, N. Y.—The contract for Section 2 of the new supply conduit has been awarded to Moffett, Hodgkins & Clarke, New York, for $857,553. There will be 26½ miles of 38-in. steel pipe.

STANHOPE AND NETCONG, N. J.—A board of trade has been organized, one of the objects of which is to secure water-works and electric lights.

ALLEGHENY, PA.—A contract for two 2,500,000-gallon pumping engines has been awarded to the Wilson-Snyder Mfg. Co. for $21,000; also for 18 smoke consumers, to the Western Smoke Preventer Co., for $1,800.

DUNKIRK, N. Y.—The Commissioners have decided to extend the intake pipe further into the lake.

LITITZ, PA.—It is reported that sufficient stock subscriptions have been secured by the Lititz Water Co. to change from a fire protection and street sprinkling system to works for general supply.

McKEESPORT, PA.—The Versailles Water Co. has been incorporated; $5,000; Treas., Thos. H. Thorn.

WEST HAZLETON, PA.—The West Hazleton Water Co. has been incorporated; $1,000; Treas., Wm. Kisner, Hazleton.

WILLIAMSPORT, PA.—The two companies here, which act together, have decided to add a 5,000,000-gallon pumping engine to the station near Lycoming Creek and to extend the mains.

Southern.

HAMPTON, VA.—The Hampton Water & Mfg. Co. has been incorporated.

HARRISONBURG, VA.—Recorder Wm. A. Slater informs us that an increased supply is proposed.

POCAHONTAS, VA.—The Pocahontas Light & Water Co. has been incorporated; $100,000.

MOBILE, ALA.—Louis Stein has made a proposition to the city to extend his works, if the city will contract for hydrants.

BROWNSVILLE, TENN.—Cy. Secy. Wm. Thomas writes that works are wanted.

CLEVELAND, TENN.—Engrs. Spencer & Black, Dalton, Ga., have reported on works with a supply from Payne Spring, and a stand-pipe; estimated cost, $35,000 to $40,000.

North Central.

CLEVELAND, O.—Bids will be received until Feb. 8 for about 4,400 ft. of 36-in. pipe, 20,000 ft. of 16-in. and such other sizes as may be needed during the year. R. R. Herrick, Dir. Pub. Wks.

BIG RAPIDS, MICH.—Recorder A. B. Cogger informs us that improvements are planned.

Northwestern.

OAKLEY, KAN.—Works are projected.

WALKERVILLE, MONT.—The Butte and Moulton Water Cos. have each made propositions to supply water.

Southwestern.

SEDALIA, MO.—The Water & Light Co. has been incorporated; $500,000; J. B. Quigley and others. This is a reorganization of the Sedalia Water-Works Co. It is said that improvements will be made.

BONHAM, TEX.—It is reported that the Council wishes bids for works.

EL PASO, TEX.—Rhodes Bros., Denver, have offered to lay a wooden conduit 6 miles long, build a 9,000,000-gallon reservoir and connect the latter with the distributing system for $157,900. The Cook Well Co., St. Louis, has offered to sink 20 wells and put in a pumping plant, the wells and pumps to have a daily capacity of 3,000,000 gallons. W. J. Williams, Dallas, offered to bore and case the wells for $3,360 each. E. S. Newman offered to furnish 20 deep well Dean pumps for $490 each.

HOPE, ARK.—It is reported that a franchise for water and electric light systems has been granted to W. J. Williams, Dallas.

VAN BUREN, ARK.—The Van Buren Water Co. has been incorporated; $50,000; Pres., T. Connor; Secy. and Treas., R. Haynes.

Pacific.

ORILLIA, WASH.—The Orillia Water-Works Co. has been incorporated; $11,610; Malcolm MacDougall, Patrick C. Hayes.

PORT TOWNSEND, WASH.—The Mayor has signed a contract with the Mount Olympus Water Co., the latter to introduce a gravity supply at an estimated cost of $300,000. There will be a long supply conduit.

WENATCHEE, WASH.—The Wenatchee Water Co. has been incorporated to supply Wenatchee Flat; $6,000.

ARTESIAN WELLS.

PRINCETON, ILL.—Supt. J. L. Huntington informs us that there is talk of sinking a well next summer.

SEWERS.

DEERING, ME.—At a meeting of the Board of City Government Jan. 13, an order was passed almost unanimously authorizing the State Commission to take immediate steps to contract with responsible parties for the construction of sewers in nine streets. Ilsley & Cummings, Portland, are engineers for the proposed system, which is estimated to cost $40,000.

LITTLETON, N. H.—Plans for the complete sewerage of this place have been completed by Geo. H. Allen, C. E., Manchester. Three systems are required, and the total length is 11⅝ miles, divided as follows: Main sewers, 15-in. Akron pipe, 8,500 ft.; branches, 12-in. Akron pipe, 42,443 ft.; 10-in., 11,018 ft. Estimated cost, $123,313. The work will probably be done by the town, a small portion at a time, and will not be contracted. About 1,100 ft. were constructed last year and 4,500 will be this year.

NATICK, MASS.—We are informed by Jas. McManus, Town Clk., that some steps have been taken toward a system of sewerage by the intermittent filtration method. The subject will probably be pushed at the spring meeting in March.

WOBURN, MASS.—The Sewerage Commissioners report that M. M. Tidd, Engr., has substantially completed plans and surveys for the proposed system. The city is divided into six districts, with discharge into the main metropolitan sewer, of Boston, at three different places, and the total cost is estimated at about $347,606, not including land damages. The total length of the city streets is 65.97 miles, and the area of the city is 8,154 acres. The elevation varies from 43 to 193 ft. above mean low tide. This system provides for nothing but house sewage, and will not be constructed in advance of the completion of the metropolitan system. The Commissioners recommend, however, that the City Council begin at once the consideration of the question.

PAWTUCKET, R. I.—The Board of Sewer Commissioners will receive bids until Feb. 10 for 4,000 ft. of 4½ to 7¼-ft. sewers, including 2,350 ft. of 7¼-ft. sewer in tunnel.

HARTFORD, CONN.—It is reported that the joint committee of the health, the street, and the park boards has decided to secure the services of Rudolph Hering, of New York, in making a survey for the Park River sewerage.

BUFFALO, N. Y.—The Board of Public Works will receive bids until Jan. 24 for 10 to 20-in tile sewers.

GRAVESEND, N. Y.—The Town Supervisor will receive bids until Jan. 21 for $40,000 of sewer bonds.

NORWICH, N. Y.—J. P. Allds, Engr., informs us that plans for a system of sewerage have been prepared by C. P. Bassett, Orange, N. J., and approved by the State Board of Health. The question of construction will be voted upon at the election in March.

ROME, N. Y.—The Stanwix Engineering Co. has about completed plans and estimates for a complete sewerage system.

HOMESTEAD, PA.—The Borough Council has voted to submit to the taxpayers a proposition to issue bonds for $30,000 for a sewerage system.

SCRANTON, PA.—Edward F. Blewitt, Cy. Engr., informs us that the city has in contemplation the construction of terra cotta pipe sewers as follows: 10th District main sewer, estimated cost $44,000; 13th District sewer, $13,000.

SOUTH BETHLEHEM, PA.—E. H. Shipman, Cy. Engr., informs us that he is making surveys and plans for a complete sewerage system, but that no definite action has been taken as to construction.

GOLDSBORO, N. C.—We are informed by A. B. Hollowell, Mayor, that a franchise was granted to the Lewis-Mercer Construction Co., New York, to construct a system of sewerage, but that the company has declined to avail itself of the franchise.

MOBILE, ALA.—A sewerage bill has been recommended to the General Council for approval by the Special Committee on Sewerage and Water-Works. It provides for authority from the legislature for investing the Mayor and General Council with power to construct sewers in the city, upon written application of three-fifths of the property owners in any district, and to make assessments to pay for the construction. Plans for a sewerage system are being prepared by S. M. Gray, Providence, R. I., as stated in our issue of Aug. 18.

RICHMOND, KY.—S. Parrish, Cy. Engr., informs us that the city is considering the construction of a sewerage system. The city has two watersheds, each leading into the Kentucky River. The total length of the system proposed is two miles, and the question of construction will probably be left to a vote of the citizens.

LONDON, O.—It is reported that $70,000 will be spent in new sewers.

MUNCIE, IND.—The city will build several pipe sewers this year. W. H. Wood, Cy. Engr.

ANN ARBOR, MICH.—Geo. F. Key, Cy. Engr., informs us that the question of a sewerage system will come up at the spring election next month. The separate system is proposed, and the plans were prepared by Prof. C. E. Greene, of the University of Michigan. The total length is about 20 miles and the estimated cost is $120,000 to $150,000. The Sewerage Committee recommends that authority be procured for the issue of bonds for $22,000 or $23,000 for the construction of the main sewers, and that these be built as soon as possible. The work will probably be done by local labor under the direction of the City Engineer, and the present plan will thus provide for work for several years.

WEST SUPERIOR, WIS.—A. S. Cooper, Cy. Engr., informs us that the city has ordered one mile of sewer work, 1,000 ft. of which is 10 ft. in diameter. Last season 7.97 miles of sewers were constructed, at a cost of $193,483, and it is probable that more work will be done this year than was done last year. The city now has 44.75 miles of sewers, which have cost $876,183.

KANSAS CITY, MO.—Plans are being prepared for a new sewer in the eastern part of the city. There will be two miles of 2 to 4¼-ft. brick and 16,750 ft. of 12-in. pipe sewer, and the estimated cost is $56,000 to $60,000.

ST. JOSEPH, MO.—A. V. Powell, Chicago, Ill., has been employed to assist W. W. Graves, Engr., in preparing plans and specifications for a system of sewers in this city. Mr. Powell was consulting engineer in the building of the city water system.

STREETS.

NEW BEDFORD, MASS.—The Superintendent of Public Works reports that nearly $200,000 will be needed by his department for the work of 1893. The estimate includes: Macadam streets, $50,000; curb and gutters, 40,000 ft., $40,000; grading, $20,000; paving, $25,000; sidewalks and crosswalks, $10,000.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Jan. 27 for grading in Sixth Ave. and 40th, 44th and 49th Sts.

GRAVESEND, N. Y.—The Town Supervisor will receive bids until Jan. 21 for $150,000 of improvement bonds.

NEW YORK, N. Y.—The Commissioner of Public Works has submitted a list of streets to be paved this year. The work aggregates 142,020 sq. yds. of granite blocks, estimated to cost $568,080, and 224,745 sq. yds. of asphalt, $898,980. Proceedings have been ordered for opening 35 new streets in the Annexed District.

EASTON, PA.—Bids will be received until Feb. 2 for paving 9,800 sq. yds. with vitrified paving brick on 6 ins. of concrete. H. R. Fehr, Cy. Engr.

MONONGAHELA CITY, PA.—We are informed by Geo. D. Jenkins, Cy. Engr., that the contracts for paving Main St. with vitrified brick will be awarded about Feb. 1. The city spent $20,000 for brick paving last year.

CINCINNATI, O.—The final estimate for paving Gilbert Ave. with granite is $101,940. Jester St. is to be paved with brick from Gordon St. to Pitts St. The City Auditor has been authorized to sell Montgomery road bonds to the amount of $150,000.

LIMA, O.—We are informed by R. H. Gamber, Asst. Cy. Engr., that he has prepared specifications for paving the public square with brick. The work will include about 13,000 sq. yds. of paving and 1,400 lin. ft. of 6-in. stone curb, and specifications can be procured after Feb. 10.

ANDERSON, IND.—E. M. Culp, Cy. Engr., writes us that the city has completed 16 miles of sewers and two miles of paving. About three miles of brick paving is to be constructed this coming summer, the contracts for which will probably be awarded next month.

ELKHART, IND.—The City Council is considering ordinances for about two miles of brick paving.

INDIANAPOLIS, IND.—The Board of Public Works has adopted resolutions for grading and paving with asphalt Talbott Ave., between 14th and 17th Sts., and for 3,085 lin. ft. of grading and graveling.

MUNCIE, IND.—We are informed by Wm. H. Wood, Cy. Engr., that the city will pave about 30,000 sq. yds. this coming summer. A special committee, which includes the City Engineer and the Mayor, is considering the question of material to be used, whether asphalt or brick.

PEKIN, ILL.—Geo. Eikemer, Cy. Clk., informs us that about $27,000 of street paving will be done during 1893 by special assessment.

STREATOR, ILL.—The city is considering the paving of about six miles of streets.

WEST SUPERIOR, WIS.—We are informed by A. S. Cooper, Cy. Engr., that last season the city did the following work: Grading, 9.93 miles, at a cost of $92,124; sidewalks, 14.95 miles, $29,852; paving, 8.53 miles, $318,753; sewers, 7.97 miles, $193,483; miscellaneous, $109,431. It is probable that more work will be done this coming season than was done last season.

DAVENPORT, IA.—The contract for paving for 1893 has been awarded to the Edwards & Walsh Construction Co., at $134,631. The only other bid received for the entire work was that of D. A. McGugin, $138,126.

KANSAS CITY, MO.—The Board of Public Works has voted to pave in three streets with brick, and in one with asphalt. The Secretary was instructed to ascertain upon what terms the Barber Asphalt Paving Co. would pave with a guarantee of ten years' maintenance instead of five, as now, and upon what terms it would keep the asphalt streets in repair after the guarantee had expired. We are informed by F. G. Graham, Cy. Clk., that the pavements in many of the principal streets are worn out, and that the streets require repaving. Asphalt and brick are used mostly.

ST. LOUIS, MO.—The Gibson Heights Land Co. has accepted the provisions of an ordinance whereby it agrees to grade, at its own expense, the streets bounded by Taylor Ave., King's Highway, Gibson Ave. and Manchester Road. The work is to be done under the direction of the Street Department.

ELECTRICAL.

BATH, ME.—A committee has been appointed to investigate the advisability of constructing a municipal electric light plant.

SPARTANBURG, S. C.—The Spartanburg Electric Light & Power Co. will increase its capital to $75,000.

SAVANNAH, GA.—It is reported that the People's Electric Light & Power Co. will put in a Westinghouse electric light plant, to cost $200,000; Secy., T. G. Reid.

FERNANDINA, FLA.—The City Council is considering the purchase of the plant of the Fernandina Light & Power Co. It is claimed that the plant can be operated in connection with the water-works, thereby securing better service and at less expense than at present.

VICKSBURG, MISS.—The Vicksburg Electric Transit & Light Co. has been incorporated to operate electric railway, supply electric lights, etc.

CLEVELAND, TENN.—The Cleveland Firebrick Co. is reported as about to put in an electric light plant to cost $12,500; Secy., C. J. Noel.

CHARLESTOWN, KY.—The Town Board is considering the advisability of establishing an electric light plant.

NAPOLEON, O.—We are informed by Isaiah Reist, Cy. Clk., that the city has contemplated putting in an electric light plant, but that no definite action has been taken.

RICHMOND, IND.—It is reported that the Mayor and City Council are willing to spend $40,000 for a first class electric light plant.

QUINCY, ILL.—The J. B. Schott Saddlery Co. desires bids on a 100 or 125 light-plant, to be put in at once.

ONALASKA, WIS.—The question of issuing bonds for $30,000 for a municipal electric light plant is being considered.

FERGUS FALLS, MINN.—It is reported that arrangements are being made to construct a dam across the Red River about a mile below the city, and put in an electric plant in the spring.

ALAMEDA, CAL.—City Electrician Goldthwait has been in the East studying electric light matters with a view of improving the city's plant. The machinery of the plant is six years old, and it is thought that the present expenses of supplying light are too high.

LA GRANDE, ORE.—The City Council has awarded a three-year contract to the La Grande Edison Electric Light Co. for 20 lights of 1,200 c. p. each, at $240 per month.

SANTIAGO, CHILE.—The Municipality invites bids to supply the city with electric light. Proposals will be opened March 1, in Santiago, and a deposit certificate to the order of the Municipality of $20,000 (Chilean currency), must accompany each bid. The particulars of the bid and plan of the city may be seen at the office of the Chilean Legation, London, England.

NEW COMPANIES.—Superior Electric Co., Chicago, Ill.; $300,000; F. H. Hamlin, D. H. Wilson, J. L. Clark. Independent Electric Co., Chicago, Ill.; $25,000; F. Hall, D. G. Hicks, N. D. Levin. Electric Battery Co., Chicago, Ill.; $10,000; F. L. Malmstedt, R. W. Russell E. Thorn. Burton Electric Co., Albany, N. Y.; $10,000; to manufacture and sell electrical apparatus; P. C. Burton, Howard Martin, C. P. Frey, Hawkes Electric Co., Boston, Mass.; $12,000; Pres., Jas. W. Magee; Treas., H. C. Hawkes. Girardville Electric Co., Girardville, Pa.; $5,000; Pres. and Treas., Albert Bordy. Worcester Traction Co., Newark, N. J.; $5,000,000; E. E. Danniston, E. J. Moore, C. F. Stevens, Philadelphia, Pa.; T. C. Barr, Newark.

CONTRACT PRICES.

LUMBER.—Rock Island, Ill.—Maj. A. Mackenzie, U. S. Engineer Office, has opened ten bids for 99,858 ft. of fir timber and 10,000 ft. of cedar timber, to be delivered at Keokuk, Ia. The prices ranged from $29.54 to $43 per M. ft. for fir and $25.75 to $55 for cedar timber. The lowest bid in each case was that of the Tacoma Mill Co., Tacoma, Wash., and it was recommended for acceptance. It was desired that the lumber be from the Pacific Coast.

STONE WORK AND DREDGING.—Newport, R. I.—The following lowest bids were received Jan. 9 and 10 by Capt. W. H. Bixby, U. S. Engineer Office: Stone work—Jas. Scully, Groton, Conn., at Nantucket, Mass., $2.50 and $2.60 per ton for the east and west jetty, respectively; J. V. Luce, Niantic, Conn., at Vineyard Haven, Mass., $2.40 per ton; Wm. H. Molthrop, Gales Ferry, Conn., and Benj. Stark, Jr., New London, Conn., at Block Island, $2.10 per ton, and $750 for fender piers; dredging—R. G. Packard, New York, in Pawtucket River, 42 cts. per cu. yd.; Providence River, including work at Green Jacket Shoal, 11.5 cts.; J. H. Fenner, Jersey City, N. J., in Hyannis Harbor, Mass., 16.5 cts. per cu. yd.; New Bedford Harbor, Mass., 15 cts.; C. W. Anthony, Fall River, Mass., in Newport Harbor, 12.9 cts. per cu. yd. No bid was received for dredging in Canapitsit Channel.

MACADAMIZING.—Arkansas City, Kan.—C. F. Leech, Cy. Engr., sends us the following information: The contract of 25,000 sq. yds. of macadamizing was awarded to J. L. Huey, by the City Council, Dec. 26, at 34½ cts. per sq. yd. The specification are briefly as follows: First layer, 5 ins. of hard limestone rock of such size that its largest diameter will pass through a 5-in. ring, then thoroughly rolled; second layer, 3 ins. of hard limestone rock of such size that its largest diameter will pass through a 3-in. ring, and again rolled; third layer, sufficient quantity of good clean gravel that after being again rolled the whole will be 10 ins. in thickness; the roller shall not be less than 4 tons in weight nor more than 6 ft. in length. The grading for this is being done by the city under the superintendency of the city engineer; estimated cost, $2,000.

MISCELLANEOUS.

CITY HALL PLANS.—New York, N. Y.—The Municipal Building Commission will advertise for competitive plans for a new city hall.

TERMINAL STATION.—Brooklyn, N. Y.—Bids for a new Brooklyn terminal station for the Brooklyn Bridge, referred to in our issue of last week, will be received until Jan. 25. C. C. Martin, Supt.

CRIB DAM.—Saratoga Springs, N. Y.—J. P. Gilson & Co. will receive bids until Jan. 24 for a crib dam across the Hudson River.

LOCK.—Florence, Ala.—Capt. Geo. W. Gotthals, Engr. in Charge of Tennessee River Improvements, has been notified that his suggestion for one lock on Cobert Shoals Canal, instead of two, has been accepted. The single lift lock will have a lift of 25 ft., and it is claimed will be the highest in the United States. It will be 350 ft. long and 80 ft. wide, and work will begin on it as soon as the title to the land can be secured.

DREDGING.—West Superior, Wis.—We are informed by A. S. Cooper, Cy. Engr., that $150,000 worth of dredging has been ordered done.

SEA WALL.—Alameda, Cal.—It is proposed to construct a sea wall 19,000 ft. long at a cost of $16),000. The City Engineer and Street Superintendent have reported on the subject.

STREET CLEANING.—Philadelphia, Pa.—The Director of Public Works has awarded contracts for street cleaning. During 1892 the amount expended was $528,759; and for 1893 it will be $609,178.

CITY HALL.—Detroit, Mich.—The Board of Estimates has adopted a resolution authorizing the Controller to issue $350,000 of public building bonds for the enlargement of the city hall.

DRY DOCK.—Vancouver, B. C.—The Board of Trade has indorsed the report of the committee on the dry dock scheme, and decided to request the City Council to advertise for propositions for the construction of a dry dock on Barrard inlet; bids to be in by Feb. 4.

DITCH.—Maumee, O.—The County Commissioners have ordered the building of the Winslow ditch, which has been under consideration for some time.

DREDGING.—Bids for dredging will be received by the U. S. Engineer Corps, as follows: Port Jefferson Inlet, N. Y., Jan. 18; Virginia and North Carolina waters, Norfolk, Va., Jan. 26; Philadelphia, Pa., Jan. 31; Saugatuck River, and Stamford Harbor, Conn., Feb. 2.

GASOLINE LIGHTING.—St. Paul, Minn.—The city has awarded the contract for furnishing the material and lighting about 3,325 gasoline lamps for three years, to Robert Seeger, at $1.24 per lamp per month.

GAS COMPANIES.—Peoples' Gas Saving Association of N. J., Newark, N. J.; $100,000; M. Kelly, of Washington, D. C., and C. H. Harrison and C. E. Baldwin, of Newark. The Consumers' Gas Co., Terre Haute, Ind., has been incorporated with a capital of $100,000, and granted a franchise.

NATURAL GAS.—Warren, Pa.—The Warren & Chautauqua Gas Co. has been organized with the following officers: Pres., G. W. Sill; Treas., I. S. Allen. Gas has already been piped down as far as Glade, and the new company will commence work at once.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for 15 ten-wheel and 20 consolidation four-cylinder compound engines for the Norfolk & Western; and an order for 25 ten-wheel freight engines for the Atlantic & Pacific. The Brooks Locomotive Works, Dunkirk, N. Y., have built 15 ten-wheel engines, with cylinders 19×26 ins., for the Santa Fe, Prescott & Phoenix. The Schenectady Locomotive Works, Schenectady, N. Y., have an order for 5 ten-wheel freight engines for the Chicago, St. Paul, Minneapolis & Omaha. The Rhode Island Locomotive Works, Providence, R. I., have an order for 10 ten-wheel passenger engines for the Boston & Albany. A light engine is wanted by Brown & Fleming, Longview, Tex.

CARS.—The Ohio Falls Car Co., Jeffersonville, Ind., has orders for 6 passenger cars for the Atlanta & West Point, and 12 passenger cars and 100 freight cars for the East Tennessee, Virginia & Georgia. The Litchfield Car Co., Litchfield, Ill., has an order for 500 box cars for the Indiana, Illinois & Iowa. The Rodgers Ballast Car Co., Chicago, Ill., has order for 400 ballast cars for the Great Northern, 100 for the Missouri, Kansas & Texas, and 25 for the Minneapolis, St. Paul & Sault Ste. Marie. The Roanoke Machine Works, Roanoke, Va., are building 500 hopper bottom coal gondola cars, 28 cabooses and 2 wrecking cars for the Norfolk & Western. The Wabash is introducing vestibule day cars, 70 ft. long, accommodating 80 passengers.

CAR WORKS.—C. D. Morse, of Millbury, Mass., is at the head of a project to establish works for building electric cars.

CAR WORKS.—A company has been organized by John M. Bass, of Fort Wayne, Ind., and others, to build car works and car wheel works at Lenoir, Tenn., 20 miles from Knoxville; the works will cost about $250,000, and machinery is already being ordered. The Akron Car Co., Akron, O., will build new works for the manufacture of passenger and street cars; Secy., O. W. Hall; Supt., J. C. Boyd.

MACHINE TOOLS.—The Brooks Locomotive Works, Dunkirk, N. Y., have placed orders with Bement, Miles & Co., Philadelphia, Pa., and the Niles Tool Works, New York, N. Y., for heavy tools, and with the Morgan Engineering Co. for an electric traveling crane, 78 ft. 6 ins. span, of 20 tons capacity, for the boiler shop.

ROAD ROLLER.—The City Council of Kokomo, Ind., will purchase a steam roller. Cy. Engr., A. W. Smith.

CATTLEGUARDS.—The Q & C Co., Chicago, announces that it has acquired the device which has been know on the market for the past year as the Standard cattleguard (Nov. 17, 1892), which is reported as having had great success. The company will sell this device, and will also bring out a new cattleguard, which will be called the "Q. & C.," and which it is claimed, will be a considerable improvement.

THE AMERICAN ALUMINUM CO., St. Louis, Mo., has completed plans for the construction and erection of the 25-ton plant, and will give out contracts for buildings, steam plant, etc. The immediate output of this plant will be about 10,000 lbs. of aluminum per day.

THE NEW YORK EQUIPMENT CO., New York, N. Y., dealing in railway track material, etc., has issued a neat vest pocket memorandum tablet and calendar.

THE JONSON ENGINEERING & FOUNDRY CO., New York, N. Y., is completing the cable crossings at 125th St. and Third Ave. This is difficult work, as the Third Avenue cable has to be depressed to allow the 125th St. cable to pass over it; and it contains all the movable iron and pivotal elevating work which is somewhat complicated machinery. This company built complete the original cable road through 125th St., from river to river, 2½ miles of double track. It has this summer built several cotton harvesting machines, which are said to have been a great success. The company has had all the work it could do up to the first of the year, and its railway crossing, gate and fire hydrant business goes on regularly.

NEW COMPANIES.—National Railway Signal Co., Omaha, Neb.; $1,000,000; B. A. Carr and C. H. Broderick. Ross-Keilar Brick Machine Co., St. Louis, Mo.; $60,000; R. N. Ross, M. S. Bowman and Eugene McQuillan. Toledo Terminal Railway & Dock Co., Toledo, O.; $200,000; Wm. Baker, John C. Clarke and F. D. Suydam.

CURRENT PRICES.

RAILS.—New York: $29 at eastern mills; $30 at tidewater; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $21 for iron and $15 to $15.50 for steel. Chicago: $30 to $32 for standard sections; old rails, $18 to $18.25 for iron, and $12.50 to $15 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2.05 to 2.1 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10% on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $12 to $14. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.85 cts.; Chicago: 3.6 to 3.7 cts.; St. Louis: 3.55 cts.

STRUCTURAL MATERIAL.—New York: beams, 2 to 2.25 cts. for large lots, and 2.55 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.65 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts.; channels, 2 to 2.1 cts.; angles, 1.65 to 1.75 cts.; tees, 2.1 to 2.15 cts.; Z bars, 1.85 to 1.9 cts.; universal mill plates, 1.7 to 1.75 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.7 to 1.75 cts. for tank, 1.95 to 2.1 cts. for shell, 2.05 to 2.15 cts. for flange, 3.4 to 3.45 cts. for firebox, 1.9 to 2 cts. for bridge. Chicago: beams, 2.17 to 2.25 cts.; channels, 2.27 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; universal plates, 1.9 to 2 cts.; steel plates (at mill), 1.9 to 2 cts. for tank, 2.12 to 2.25 cts. for shell, 2.25 to 2.75 cts. for flange, 2.7 to 2.8 cts. for firebox. The "Iron Age" says that the price at which the recent elevated work in Chicago was taken is given at 3 cts. erected, which is, considering the local labor market, the lowest on record for this class of work.